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NATIONAL DAM INSPECTION PROGRAM. STOVERS DAM (NDS-PA-00600, DER--ETC(U)
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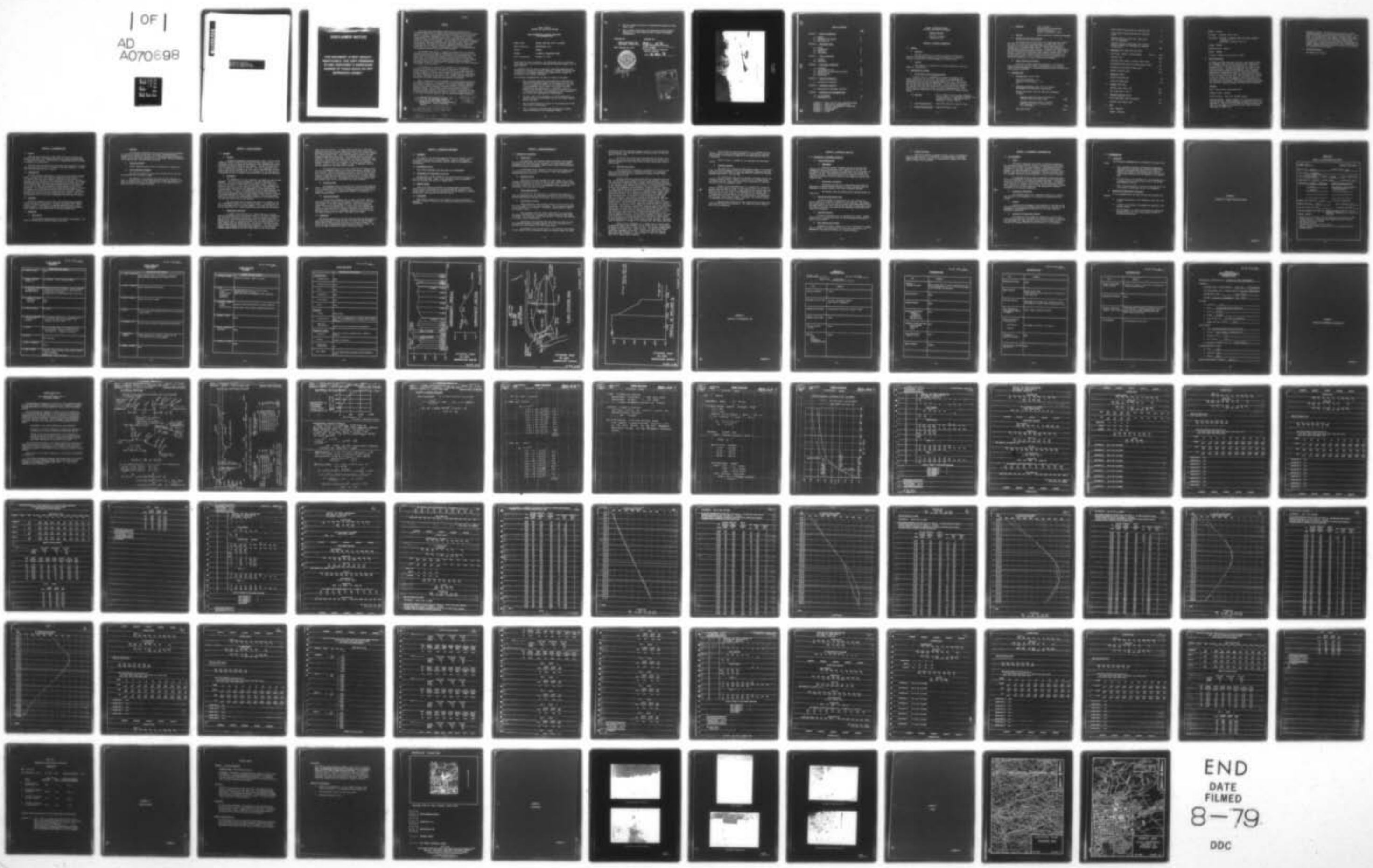

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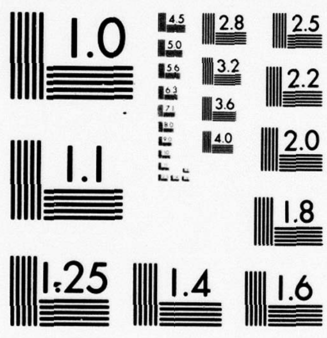

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PREFACE

This report has been prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evoluntionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The spillway design flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

(6) National Dam Inspection Program. Stovers Dam (NDS-PA-ØØ6ØØ, DER-38-5), Susquehanna River Basin, Lebanon County, Pennsylvania. Phase I Inspection Report.

(11) Feb 79

(12) 93p.

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PHASE I REPORT
NATIONAL DAM INSPECTION PROGRAM

BRIEF ASSESSMENT OF GENERAL CONDITIONS AND RECOMMENDATIONS

Name of Dam:	STOVERS LAKE DAM, NDS NO. PA-00600
State & State No.	PENNSYLVANIA, 38-5
County:	LEBANON
Stream:	A BRANCH OF BRANDYWINE CREEK
Date of Inspection:	November 15, 1978

Based upon the visual inspection, past performance and the available engineering data, the dam and its appurtenant structures appear to be in poor condition.

In accordance with the Corps of Engineers' evaluation guidelines the combination of storage and spillway capacity is capable of passing only 11 percent of the Probable Maximum Flood (PMF) and the spillway is considered to be seriously inadequate.

The following recommendations are made for action by the owner:

1. That a detailed engineering investigation be conducted by a qualified professional engineer to determine the source and cause of the observed seepage and soft condition at the toe of the embankment, and to assess the influence of these conditions on the stability of the structure. Also, to determine what measures should be taken to improve the capacity of the spillway to meet the requirements of the criteria as set forth by the Commonwealth of Pennsylvania.

2. That the crest of the embankment be raised immediately to a uniform elevation as the initial step to the overall improvements to the dam.

3. That a positive method of closure of the upstream end of the outlet pipe be established.

4. That a procedure be developed and implemented to provide regular maintenance of the embankment slopes.

5. That the blowoff facilities be operated and serviced at least twice a year.

6. That a formal surveillance and downstream warning system be developed to be used during periods of high or prolonged precipitation.

SUBMITTED BY:

BERGER ASSOCIATES, INC.
HARRISBURG, PENNSYLVANIA

DATE: February 20, 1979

COMMONWEALTH OF PENNSYLVANIA
REGISTERED PROFESSIONAL
HENDRIK JONGSMA
ENGINEER
No. 5557E

APPROVED BY:

G. K. WITHERS
Colonel, Corps of Engineers
District Engineer

DATE 18 Mar 79

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OVERVIEW
STOVERS DAM

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PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

STOVERS LAKE DAM

NDS-ID NO. PA-00600
DER-ID NO. 38-5

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

A. Authority

The dam Inspection Act, Public Law 92-367 authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of inspections of dams throughout the United States.

B. Purpose

The purpose is to determine if the dam constitutes a hazard to human life and property.

1.2 DESCRIPTION OF PROJECT

A. Description of Dam and Appurtenances

+ or -

Stovers Dam is a 160± year old earthfill embankment with a masonry spillway at its left end. The length of the embankment is approximately 250 feet and the maximum height is 25 feet. The 18 foot wide broadcrested spillway was originally three feet below the top of the dam, but has been raised a few inches. A gate structure, located on the upstream side, has been sealed off and the control on the 12-inch blowoff pipe is located in a valve pit near the downstream toe. This pipe is the only known pipe in the embankment and has no upstream closure control.

B. Location: City of Lebanon & North Lebanon Township, Lebanon County, U.S. Quadrangle, Lebanon, PA. Latitude 40°-20.8', longitude 76°-24.2' (Appendix F, Plates I and II)

C. Size Classification: Small (282 acre-feet, height 25 feet)

D. Hazard Classification: High (See Section 3.1.E)

E. Ownership: City of Lebanon
Lebanon Recreation Department
400 South 8th Street
Lebanon, Pennsylvania 17042

F. Purpose: Public Recreation (Fishing and Boating)

G. Design and Construction History

The dam was built by the Union Canal Company in about 1820 by day labor as a feeder for the Union Canal. In about 1868, the top elevation of the dam was raised when additional lockage water was required due to increased barge traffic. A ditch was excavated in a southeasterly direction to feed the canal. Ownership was transferred to the Philadelphia and Reading Rail Company and then to the Lebanon Water Company, a subsidiary of Bethlehem Steel Company, Lebanon Plant. The dam and reservoir were recently acquired by the City of Lebanon for recreational purposes. Due to the age of the dam, no design or construction information for these facilities are available.

H. Normal Operating Procedures

There are no formal operating procedures. All inflow is either stored below spillway crest or discharged over the spillway. Seepage through embankment or foundation generally keeps the water level below spillway elevation.

1.3 PERTINENT DATA

A. Drainage Area (square miles)

From file information - 1.1
Computed for this report - 1.1
Use 1.1

B. Discharge at Dam Site (cubic feet per second)
See Appendix C for hydraulic calculations

Maximum known flood, June 22, 1972 (dam overtopped 1/2-inch)

Inflow estimated on basis of records for USGS gage Beck Creek near Cleona 1,100

Outflow estimated on basis of reported pool elevation (541.4) (includes flow over embankment) 550

Warm water outlet None

Outlet works low pool outlet at pool Elev.520	4
Outlet works at pool level Elev.537 (spillway crest)	9
Spillway capacity at pool Elev. 539.7 (low point in embankment)	210
Spillway capacity at pool Elev. 542.3 (top of spillway abutment) if embankment is restored to that level	580

C. <u>Elevation</u> (feet above mean sea level)

Top of dam - uneven - varies between	539.7 &	542.3
Spillway crest		537
Upstream portal invert of outlet tunnel, about		517
Downstream portal invert of outlet tunnel, about		515
Streambed at centerline of dam, about		517
Maximum tailwater about		520

D. <u>Reservoir</u> (miles)

Length of maximum pool	0.5
Length of normal pool	0.4

E. <u>Storage</u> (acre-feet)

Spillway crest (Elev. 537)	215
Top of dam (Elev. 539.7)	282

F. <u>Reservoir Surface</u> (acres)

Top of dam (Elev. 539.7 low point)	31
Spillway crest (Elev. 537)	20

G. <u>Dam</u>

Type: Earthfill

Length: 250 feet.

Height: 25 feet

Top Width: Irregular, about 6 feet

Side Slope: Upstream - irregular above waterline, probably 1.5H to 1V
Downstream - measured 1.6H to 1V

Zoning: Unknown

Impervious Core: Unknown

Cutoff: Unknown

Grouting: Unknown (not practiced in 1820)

H. Outlet Facilities

A 12-inch cast iron pipe, about 125 feet long, passes through the embankment from a concrete headwall at the upstream end to a concrete valve box on the downstream end. There is no upstream control. The pipes and valves in the valve box are covered with dirt. From the arrangement of the three valve stems protruding through the dirt and from other available information, it appears that there are two 12-inch valves in series on the blowoff pipe. This pipe discharges into a ditch a few feet beyond the valve box. From a 12-inch by 12-inch by 12-inch tee between the two valves, a third valve and a 12-inch water main formerly delivered water to a nearby plant of the Bethlehem Steel Company. The inspection party was informed that the steel company no longer uses this source of supply.

I. Spillway

Type: Uncontrolled, broadcrested weir.

Length of weir: 18 feet.

Crest elevation: about 537, slightly dipped.

Upstream channel: Approach channel is a paved area on the top and upstream slope of the embankment (see sketch on Sheet 1 of Appendix C). The paved area is about 24 feet long and 20 feet wide. At the edges, it is warped into the shape of the dam embankment on either side.

Downstream channel: The spillway chute is built of heavy, limestone masonry which has been patched with concrete. It is about 70 feet long and 18 feet wide. Starting at the crest, there is a two-foot drop (see Appendix A, Plate A-III), a 24-foot-long section with a 1V to 3H slope, an 8-foot-long section with a 1V to 12H slope, and finally an 8-foot drop to a plunge pool. Beyond the plunge pool, flow is delivered to a swampy, sluggish stream which is kept flowing by the considerable leakage from the reservoir.

J. <u>Regulating Outlets</u>

See Section 1.3.H above.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

This dam was constructed in about 1820 and the top elevation was raised around 1868. The PennDER files did not contain any design data or construction drawings. The checklist of engineering data is included in Appendix B of this report.

The first time the dam and its facilities were inspected by PennDER was on January 22, 1915 by F. B. McDowell, Assistant Engineer. A report was filed and submitted by Mr. Seelye.

2.2 CONSTRUCTION

The only available information is contained in the above mentioned report, stating that at that time no construction data existed. Mr. Seelye states that the foundation consisted of firm clay and that suitable clay was available in the neighborhood of the dam. The original upstream slope was unprotected, but the slope was paved with brick laid on its edge in 1884. Brick protection started about 4 feet above the toe at the silt line and continued to 2.5 feet below the top of the embankment. The downstream slope was sodded and had a slope of 1.75H to 1V, except near the left end of the dam, where the slope was flatter. The spillway crest was three feet below the top of the dam. The 12-inch pipeline had a masonry bay and a wooden gate for control. This gate was abandoned prior to 1915 and a downstream valve was used for control.

2.3 OPERATION

Records of operation do not exist. The reservoir was originally used for feeding the Union Canal. In 1880, the Lebanon Water Company acquired the dam for purposes of supplying industrial water to the Lebanon Furnace. This company and the dam were acquired by Bethlehem Steel Company, who discontinued use of the water around 1976.

2.4 EVALUATION

A. Availability

The available engineering data was obtained from PennDER. The owner of the dam did not have any data in his files.

B. Adequacy

The available engineering and construction data is not adequate to evaluate the design of this dam. The report from PennDER dated January, 1915, states that the capacity of the spillway would be approximately 250 cfs which was considered low at that time. The crest elevation of the dam has been increased since that date.

C. Operating Records

Formal operating records were not available for examination.

D. Post Construction Changes

The crest elevation of the dam was increased around 1868 and the upstream slope was paved in 1880.

The approach to the spillway was paved and last repaired in 1973. It appears that, in 1928, some concrete curbing was placed at the edges of the dam breast near the spillway and at a few other places to raise the dam to its intended elevation.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

A. General

The general appearance of Stovers Dam is poor. The top of the breast is uneven in width and elevation with many erosion gullys. The embankment slopes are steep and according to local residents the dam was overtopped by several inches in 1972 (Agnes). The dam is owned by the City of Lebanon and is used for fishing. The visual inspection check list is contained in Appendix A of this report. Reproductions of photographs taken during the inspection are in Appendix E. Mr. Ken Barrick represented the City of Lebanon, Parks Department, during the inspection.

B. Embankment

The embankment is in poor condition, due mainly to poor vertical alignment. The top of dam was designed to be three feet above the spillway. The actual average height is at present 4 feet with a low point of only about 2.7 feet above the spillway. Refer to Appendix A, Plates A-I and A-II, for the results of the survey. The dam breast has a very uneven cross section, with many gullys at the downstream and upstream edges. The top of the embankment is used by many fisherman and there is no cover. Pieces of concrete curbing are at several places. The upstream embankment slope has many bulges, probably caused by dumping riprap and cementing the surface against erosion. The lake was drawn down in 1972 and the city representative stated that the upstream slope is paved with brick over its full surface.

The downstream slope is steep (see Plate A-1, Appendix A) and has a considerable amount of weed and shrub growth. The downstream toe is wet and swampy west of the valve chamber. The slope was soft up to one foot above the toe. Actual seepage discharge could not be detected.

C. Appurtenant Structures

A concrete intake structure is located upstream of the dam with its top surface just above the pool level at the time of inspection. The top of the structure is sealed off. When the reservoir was drawn down in 1972, a new grating was installed over the intake opening at the bottom of the tower. A twelve-inch pipe runs from this structure to a valve chamber near the downstream toe. One valve on this pipe is operable and was partially opened during the inspection. The same pipe has another valve upstream in the same valve chamber in an open position. Another pipeline takes off of the 12-inch line, but it is not known

where this pipe leads to. It could possibly feed into a line which crosses the spillway discharge channel and leads to the Lebanon Plant of Bethlehem Steel Corporation. The spillway, located in the left abutment, has a paved approach slab. This slab was poured in 1973 to cut down seepage through the spillway weir. The abutment walls are in good condition. The spillway discharge channel is concrete paved with stone walls and a plunge pool which functions as the energy dissipator. Some seepage through the walls is occurring, but this is not considered serious. Access to the valve chamber, in case of emergency, would be from the cemetery at the right end of the dam.

The representative of the City stated that the reservoir did not top the embankment during the tropical storm Agnes, although it was within inches. The only overtopping occurred to the left of the spillway. Local residents, who probably observed the dam on a more regular schedule, stated that the dam actually overtopped a few inches during a period of about two hours. The reservoir pool level just before Agnes was probably about 10 to 15 feet below weir crest elevation.

D. Reservoir Area

The immediate area of the reservoir is flat and the banks are stable. The watershed is mostly farmland with some house developments. It is estimated that about 2-feet of sedimentation has occurred in the reservoir. At present the sedimentation problem is reduced due to better farming methods.

E. Downstream Channel

The spillway discharges into a narrow, relatively shallow creek which makes a sharp turn just below the plunge pool. The creek runs parallel to the dam, along a cemetery. About four houses are located close to the stream before it joins with Little Brandywine Creek. If the dam would fail due to overtopping, the floodwave would cross the creek, run across a baseball field and could increase the hazard to loss of life at a development immediately south of the dam. The hazard category of this dam is considered to be "High".

3.2 EVALUATION

The visual inspection of this dam indicates that the dam breast is narrow and irregular in width and has a very poor vertical alignment. Steps should be taken to raise the dam to its required height (see Section 5) and the embankment slopes should be cleared of brush. The top of the dam is narrow and without a protective cover.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURE

The reservoir and dam were bought by the City of Lebanon to serve as a recreational facility, mostly fishing. There are no specific procedures to operate the reservoir and all inflow is discharged over the spillway.

4.2 MAINTENANCE OF DAM

Very little maintenance has been done on the embankment.

4.3 MAINTENANCE OF OPERATIONAL FACILITIES

No maintenance of the facilities has occurred since the approach to the spillway was paved. There is no procedure to open the drawdown valve or to grease the valve on a regular basis.

4.4 WARNING SYSTEM

There is no formal surveillance or warning system in existence. During tropical storm Agnes the city representatives visited the site several times, but the critical condition of the dam requires a constant surveillance during periods of high pool levels.

4.5 EVALUATION

Operational procedures are very limited at present and should be expanded. A formal surveillance and downstream warning system should be implemented.

SECTION 5 - HYDROLOGY/HYDRAULICS

5.1 EVALUATION OF FEATURES

A. Design Data

The hydrologic and hydraulic analysis available from PennDER for Stovers Lake Dam was not very extensive. No area-capacity curve, frequency curve, unit hydrograph, design storm, design flood hydrograph, nor flood routings were available.

A seven-page report prepared in 1915 listed the distance from the spillway crest to the top of the dam as 3 feet, and reported the spillway capacity as 250 cfs.

B. Experience Data

There were no records available for past floods, but a local resident recalled that the flood of June 22, 1972, raised the pool level to within a few inches of the top of the spillway wall. He also recalled that water flowed over the top of the embankment at many places and continued to do so for about two hours.

C. Visual Observations

On the date of the inspection, no conditions were observed that would indicate that the appurtenant structures of the dam could not operate satisfactorily during a flood event, until the dam is overtopped.

D. Overtopping Potential

Stovers Dam has a total storage capacity of 282 acre-feet and an overall height of 25 feet above streambed. These dimensions indicate a size classification of "Small". The hazard classification is "High" (see Section 3.1.E).

The recommended Spillway Design Flood (SDF) for a dam having the above classifications is one-half the Probable Maximum Flood (PMF) to the PMF. For this dam, the PMF peak inflow is 3,230 cfs (see Appendix C for HEC-1 inflow computations).

Comparison of the estimated PMF peak inflow of 3,230 cfs with the estimated spillway discharge capacity of 210 cfs indicates that a potential for overtopping of the Stovers Dam exists.

An estimate of the storage effect of the reservoir and routing of the computed inflow hydrograph through the reservoir shows that this

dam does not have the necessary storage available to pass the PMF without overtopping. The spillway-reservoir system can pass a flood event equal to 11% of a PMF.

If the low area in the top of the dam would be raised to the level of the top of the spillway walls (Elevation 542.3) the spillway-reservoir system will still only be able to pass a flood event equal to 26% of a PMF.

E. Dam Break Evaluation

The calculations to determine the behavior of the dam in the event of an overtopping and a resulting breaching of the embankment indicates that there will be a substantial increase in water levels downstream from the dam.

Several houses are located about 750 feet downstream from the dam. On the basis of the results of the dam break analysis, using the U.S. Army Corps of Engineers HEC-1 program, the water surface elevation in the vicinity of the houses would be about 514.7 when the water surface in the reservoir above the dam is just at the crest elevation (low point) of the embankment (no overtopping). Refer to Table 1, Appendix C. Since this dam has been overtopped by the flood of record, and since that flood did not cause a breach, it is estimated that a breach would result when the water level reaches an elevation 0.5 feet higher than the flood of record. It is expected that 30 percent of a PMF would cause the water level in the lake to reach an elevation that would result in a breach. Just prior to failure by the 30 percent PMF flow, the water surface elevation downstream would be about 515.8. The increase due to overtopping under no failure condition would be approximately (515.8 - 514.7) 1.1 feet. While more property would be exposed to flooding, the increase to the danger of loss of life is not considered significant. With failure, however, the breaching analysis indicates a rise of about 4.1 feet above the flow level just prior to breach when considering a 15 minute time to complete the breach and about a 1.8 feet rise above flow level just prior to breach when considering a 2 hour time to complete the breach. The increase in hazard to loss of life and property damage is reflected not only in the increase in depth of water of 4.1 feet in the 15 minute breach and 1.8 feet in the 2 hour breach, but more significantly in the shorter time to reach the peak. Less time would be available to respond to the flooding under the breach conditions.

Being an earth embankment, it is judged that the breach would be completed between the 15 minute and the 2 hour period. The numerical difference of water levels is about 2.3 feet. The property damage would be similar with either time. Again, however, the time factor is most significant regarding loss of life. Calculations indicate that the water depth will increase at a rate of about 4.1 feet in 15 minutes under the 15 minute breach condition.

On the basis of these calculations, it is concluded that the hazard to loss of life and property damage is significantly increased when the dam is overtopped as compared to the condition just prior to overtopping.

Refer to Table 1, Appendix C, for comparison of flood water levels.

F. Spillway Adequacy

The small size category and high hazard category, in accordance with the Corps of Engineers criteria and guidelines, indicates that the Spillway Design Flood (SDF) for this dam should be one-half the Probable Maximum Flood (PMF) to the full PMF.

The calculations show that the spillway discharge capacity and reservoir storage capacity combine to handle 11% of the (PMF) without overtopping the dam. These calculations have considered the existing low point along the embankment crest.

Being an earth embankment dam, it is judged that a breach is likely to develop when the depth of flow over the crest is 0.5 foot or greater than the flood of record. These studies also indicate that the depth of flow over the crest of the embankment due to one-half PMF is more than the 0.5 foot criteria. On the basis of this information, it is judged that a one-half PMF will cause overtopping of the embankment and will most likely cause a breach. Therefore, the spillway capacity is considered to be seriously inadequate.

The hydrologic analysis for this investigation was based upon existing conditions of the watershed. The effects of future development were not considered.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

A. Visual Observations

1. Embankment

The poor vertical alignment and narrow and irregular width of the top of the dam gave a poor impression of the dam. No sloughage or cracking was noticed, but many gullys were in existence at the top of the dam. The downstream slope is steep, and seepage was evident at the toe. The dam has been in this condition for over 100 years and no failures have been reported, even though the dam was overtopped in 1972.

2. Appurtenant Structures

The masonry spillway is in reasonablly good condition. Some water is seeping through the masonry joints, indicating that the embankment or natural ground in this area is somewhat pervious.

The blowoff valve was satisfactorily operated during the inspection.

B. Design and Construction Data

Records of design or construction were not available for review; thus, an evaluation of stability is not feasible. The embankment slopes appear to be too steep for present good engineering practice. The small width of the top of the dam and the lack of protection in this area raises a question as to whether this embankment could again withstand any overtopping.

C. Operating Records

Records of operation were not available for review. Persons living close to the dam stated that the dam overtopped during Agnes at some of its low spots.

D. Post Construction Changes

Reference is made to Section 2.4.D for a discussion of changes made to the dam. The installation of curbs along some parts of the embankment to increase the height is no longer effective.

E. Seismic Stability

This dam is located in Seismic Zone No.1 and it is considered that the static stability is sufficient to withstand minor earthquake induced dynamic forces. However, no calculations, studies, etc., were made to confirm this conclusion.

SECTION 7 - ASSESSMENT & RECOMMENDATIONS

7.1 DAM ASSESSMENT

A. Safety

The visual inspection, the review of available information, the operational history and the hydraulic calculations for this report indicate that this dam is in poor condition. The downstream slope is considered to be steep, although no signs of distress were noticed. Seepage in an unknown quantity is occurring through the spillway walls and the right (west) end of the embankment. The top of the dam, with its irregular and narrow width and gullies is also a point of concern.

In accordance with the Corps of Engineers' evaluation guidelines, the combination of storage and spillway capacity is sufficient to pass only 11 percent of the Probable Maximum Flood (PMF). Overtopping of the dam with an inflow of 30 percent of the PMF would most likely cause a failure of the dam. Such a failure would significantly increase the hazard to loss of life downstream. The spillway is, therefore, considered to be seriously inadequate.

B. Adequacy of Information

The available data is not considered sufficient to evaluate the stability of the embankment or to assess the seriousness of the seepage.

C. Urgency

Because of the inadequacy of the spillway of this dam and the uncertainties regarding the seepage conditions and the stability of the embankment, the recommendations presented in this report should be implemented immediately.

D. Necessity for Additional Studies

The results of this inspection indicate the need for additional detailed hydrologic, hydraulic, and stability studies to determine the requirements for improving the capacity of the spillway and to evaluate the seepage conditions and the stability of the embankment.

7.2 RECOMMENDATIONS

A. Facilities

The following recommendations are presented for action by the owner:

1. That a detailed hydrologic and hydraulic engineering investigation be conducted by a qualified professional engineer to determine what measures can be taken to improve the capacity of the spillway and to evaluate the slope seepage condition and the stability of the embankment.

2. That the crest of the embankment be raised immediately to a uniform elevation as the initial step to the overall improvements to the dam.

3. That a positive method of closing the upstream end of the outlet pipe be established for use in an emergency.

B. Operation and Maintenance Procedures

It is recommended that the owner initiate the following procedures:

1. A regular maintenance of the embankment slopes and crest of dam.

2. A twice a year schedule of greasing and operation of the drawdown valves.

3. The development of a formal surveillance and downstream warning system to be used during periods of high or prolonged precipitation.

APPENDIX A

CHECKLIST OF VISUAL INSPECTION REPORT

CHECK LIST

PHASE I - VISUAL INSPECTION REPORT

PA DER # 38-5 NDI NO. PA-00 600

NAME OF DAM Stovers HAZARD CATEGORY High

TYPE OF DAM Earthfill

LOCATION City of Lebanon and North Lebanon TOWNSHIP Lebanon COUNTY, PENNSYLVANIA

INSPECTION DATE 11/15/78 WEATHER Sunny TEMPERATURE 50's

INSPECTORS: H. Jongsma (Recorder)

R. Steacy

A. Bartlett

OWNER'S REPRESENTATIVE(s):

Ken Barrick - City of Lebanon Parks Department

NORMAL POOL ELEVATION: 537.0

BREAST ELEVATION: 542.0

SPILLWAY ELEVATION: 537

AT TIME OF INSPECTION:

POOL ELEVATION: 534.6

TAILWATER ELEVATION:

MAXIMUM RECORDED POOL ELEVATION: Agnes (14 inches below top wall at spillway. Overtopped for 2 hours 1/2" over dam.

GENERAL COMMENTS:

Bought by City of Lebanon from Bethlehem Steel Corporation in 1976.
During Agnes water overtopped east abutment and caused erosion.
Spillway approach was repaved.
Lake drained in 1972.
Upstream is paved all the way by brick.
Dam was closely observed during Agnes by local residents and city representatives.

NDI NO. PA-00 600

VISUAL INSPECTION
EMBANKMENT

	OBSERVATIONS AND REMARKS
A. SURFACE CRACKS	None.
B. UNUSUAL MOVEMENT BEYOND TOE	No movement. Toe is wet and swampy.
C. SLOUGHING OR EROSION OF EMBANKMENT OR ABUTMENT SLOPES	Upstream slope very irregular. Mostly cemented. Considerable erosion on top of dam, partially caused by foot traffic. Erosion gullys on downstream breast and slopes.
D. ALIGNMENT OF CREST: HORIZONTAL: VERTICAL:	 Fair. Poor.
E. RIPRAP FAILURES	No riprap.
F. JUNCTION EMBANKMENT & ABUTMENT OR SPILLWAY	West abutment junction o.k., although a low spot 25 feet away from abutment. East abutment ties into road.
G. SEEPAGE	Toe is wet over most of its length west of valve chamber. Ground is soft up to one foot above toe. Seepage in spillway.
H. DRAINS	None detected.
J. GAGES & RECORDER	None.
K. COVER (GROWTH)	Upstream - some cemented, some concrete walls, some sloughage. Breast - no cover. Downstream - weeds and brush.

VISUAL INSPECTION
OUTLET WORKS

	OBSERVATIONS AND REMARKS
A. INTAKE STRUCTURE	Flat concrete tower. No entrance, sealed off. Steel grating installed over intake in 1973.
B. OUTLET STRUCTURE	Valve house with 12-inch pipe.
C. OUTLET CHANNEL	Narrow and full of weeds.
D. GATES	In valve house one operable valve and 2 non-operable gate valves.
E. EMERGENCY GATE	12-inch valve, partially opened during inspection.
F. OPERATION & CONTROL	Seldom opened, last in 1972 to drain lake and 1974 and 1976 for fish management.
G. BRIDGE (ACCESS)	None.

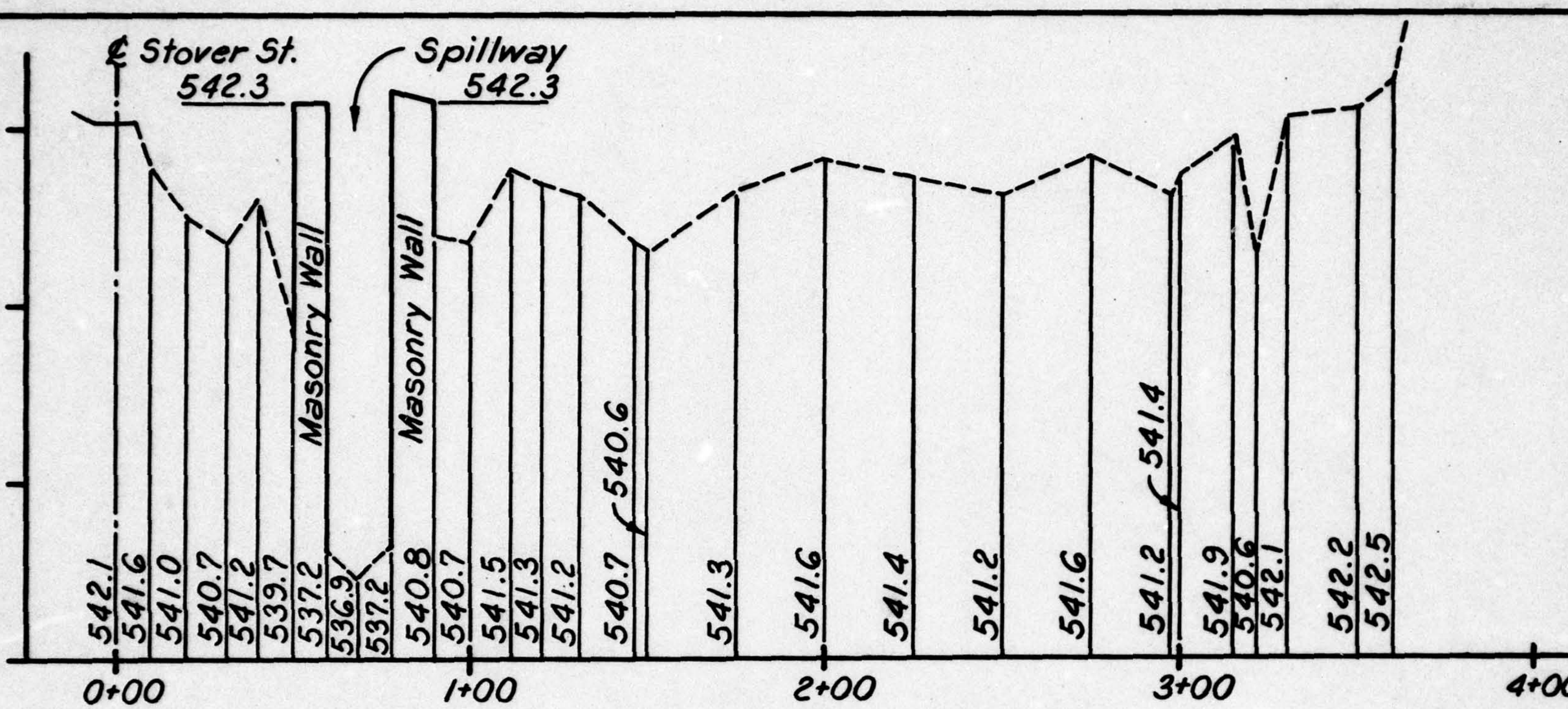
VISUAL INSPECTION
SPILLWAY

	OBSERVATIONS AND REMARKS
A. APPROACH CHANNEL	Concrete approach, dipped in center.
B. WEIR: Crest Condition Cracks Deterioration Foundation Abutments	Broadcrested weir with a two foot drop. Seeping through this drop. Walls and weir in reasonablely good condition.
C. DISCHARGE CHANNEL: Lining Cracks Stilling Basin	Concrete slab and stone walls in good condition. Stone walls, water seeping through drop section.
D. BRIDGE & PIERS	None.
E. GATES & OPERATION EQUIPMENT	None.
F. CONTROL & HISTORY	None.

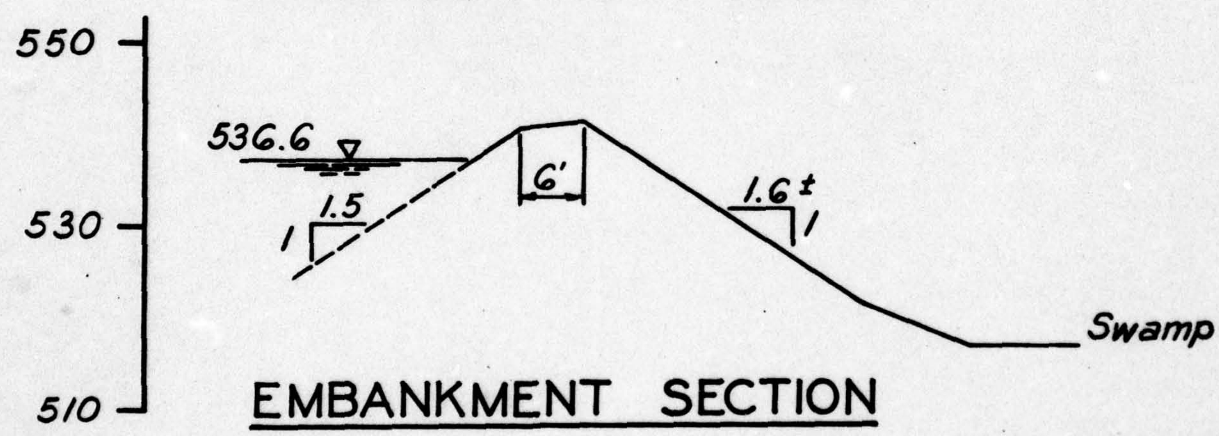
NDI NO. PA-00 600

VISUAL INSPECTION

	OBSERVATIONS AND REMARKS
INSTRUMENTATION	
Monumentation	None.
Observation Wells	None.
Weirs	None.
Piezometers	None.
Staff Gauge	None.
Other	None.
RESERVOIR	
Slopes	Mostly flat.
Sedimentation	Good bit of sedimentation at bottom, about 2 feet deep. Less sedimentation at present by controlled farming.
Watershed Description	Agriculture and some housing developments.
DOWNSTREAM CHANNEL	
Condition	Open flat terrain; baseball park, cemetery, houses.
Slopes	Grassed, developed.
Approximate Population	20
No. Homes	4 to 5 houses before joining Little Brandywine Creek.



EMBANKMENT PROFILE

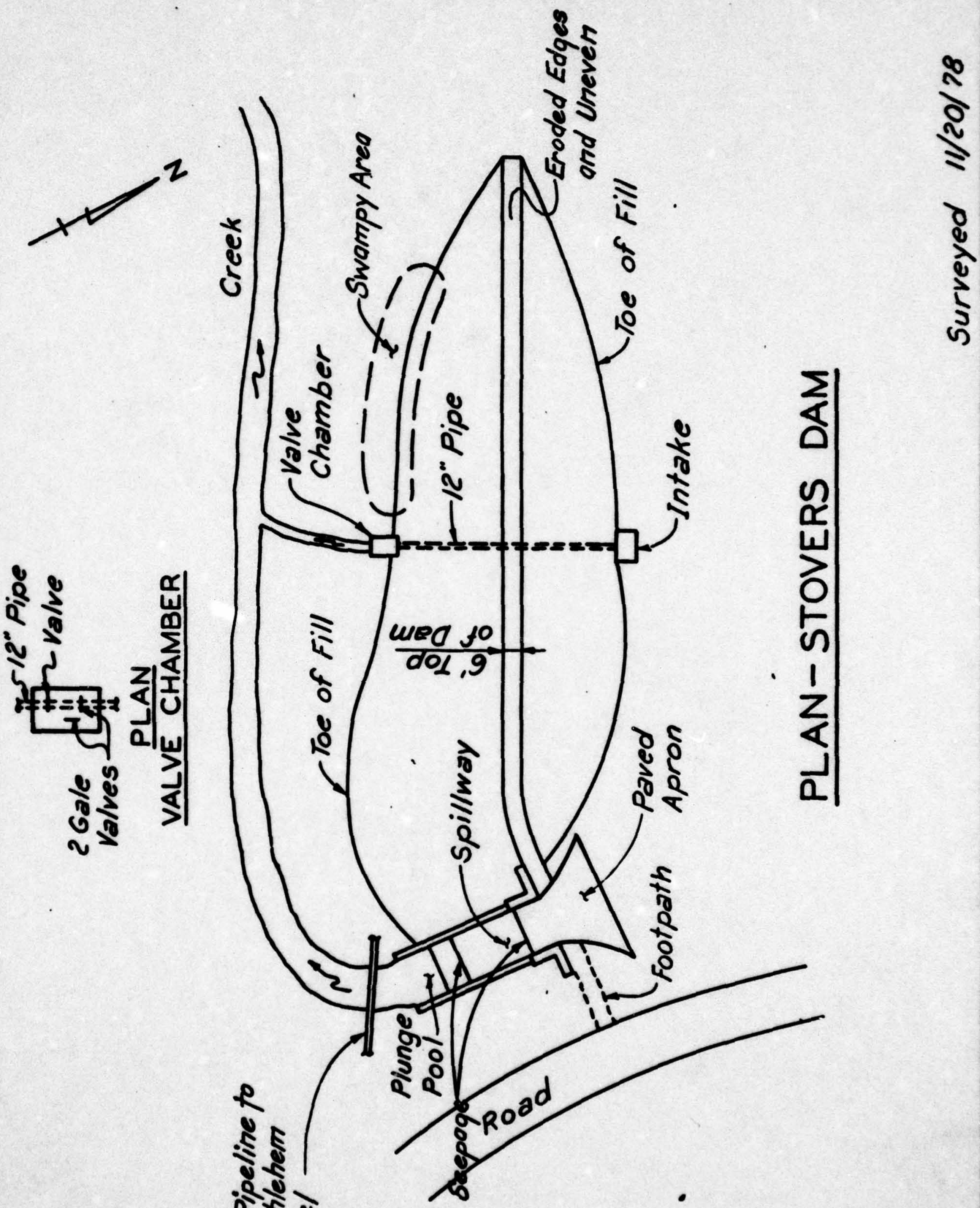


EMBANKMENT SECTION

Surveyed 11/20/78

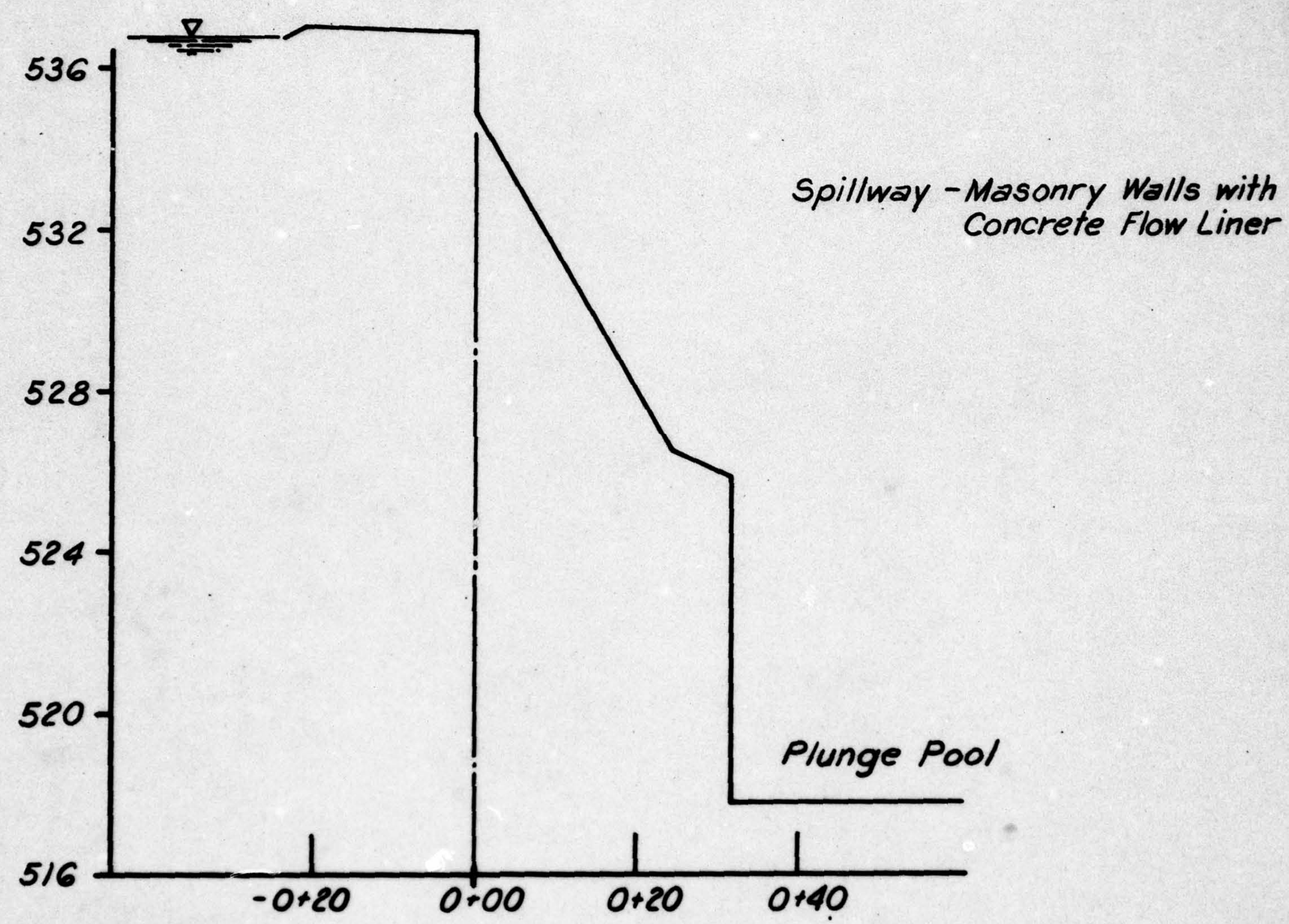
STOVERS DAM
PA. 600
INSPECTION SURVEY

PLATE A-I



STOVERS DAM
PA. 600
INSPECTION SURVEY

PLATE A-II



PROFILE OF SPILLWAY ℄

Surveyed 11/20/78

STOVERS DAM
PA. 600
INSPECTION SURVEY

PLATE A-III

APPENDIX B

CHECKLIST OF ENGINEERING DATA

CHECK LIST
ENGINEERING DATA

PA DER # 38-5 NDI NO. PA-00 600

NAME OF DAM Stovers Dam

ITEM	REMARKS
AS-BUILT DRAWINGS	None
REGIONAL VICINITY MAP	U.S.G.S. Quadrangle Lebanon See Plate II, Appendix F
CONSTRUCTION HISTORY	Constructed around 1820, raised in 1868.
GENERAL PLAN OF DAM	None.
TYPICAL SECTIONS OF DAM	None.
OUTLETS: PLAN DETAILS CONSTRAINTS DISCHARGE RATINGS	None.

ENGINEERING DATA

ITEM	REMARKS
RAINFALL & RESERVOIR RECORDS	None, except that 5.1 inch of rain fell in one hour in Lebanon on July 10, 1914 and overtopped a low area near the spillway.
DESIGN REPORTS	None.
GEOLOGY REPORTS	None.
DESIGN COMPUTATIONS: HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	None.
MATERIALS INVESTIGATIONS: BORING RECORDS LABORATORY FIELD	None.
POST CONSTRUCTION SURVEYS OF DAM	None.
BORROW SOURCES	Unknown.

ENGINEERING DATA

ITEM	REMARKS
MONITORING SYSTEMS	None.
MODIFICATIONS	Raised around 1868. Walls built on crest around 1927 to contain fill and raise dam.
HIGH POOL RECORDS	Overtopped at low spot near spillway in 1914. Overtopped at several places during Agnes (1972).
POST CONSTRUCTION ENGINEERING STUDIES & REPORTS	None, except inspection reports.
PRIOR ACCIDENTS OR FAILURE OF DAM Description: Reports:	Overtopped, see above. No reports.
MAINTENANCE & OPERATION RECORDS	None.
SPILLWAY PLAN, SECTIONS AND DETAILS	None.

NDI NO. PA-00 600

ENGINEERING DATA

ITEM	REMARKS
OPERATING EQUIPMENT, PLANS & DETAILS	No plans or details. Valve pit downstream with 12-inch pipe and valve.
CONSTRUCTION RECORDS	None.
PREVIOUS INSPECTION REPORTS & DEFICIENCIES	Inspection reports indicate leakage at toe and from a spring in right abutment since 1915. Brush and tree growth on downstream slope. Uneven breast since 1920.
MISCELLANEOUS	Some photographs since 1915.

NDI NO. PA-00 600

CHECK LIST
HYDROLOGIC AND HYDRAULIC
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: Farmland and house developments.

ELEVATION:

TOP NORMAL POOL & STORAGE CAPACITY: Elev. 537 215 Acre-Feet

TOP FLOOD CONTROL POOL & STORAGE CAPACITY: Elev.539.7 282Acre-Feet

MAXIMUM DESIGN POOL: Elev. 542.3

TOP DAM: (low point in embankment) Elev. 539.7

SPILLWAY:

a. Elevation 537

b. Type Uncontrolled broad crested weir.

c. Width 18 feet.

d. Length 70 feet

e. Location Spillover Left side of embankment

f. Number and Type of Gates None.

OUTLET WORKS:

a. Type 12-inch pipe with two 12-inch valves.

b. Location Valve chamber at downstream toe.

c. Entrance inverts 517

d. Exit inverts 515

e. Emergency drawdown facilities 12-inch blowoff.

HYDROMETEOROLOGICAL GAGES:

a. Type None.

b. Location None.

c. Records None.

MAXIMUM NON-DAMAGING DISCHARGE: 850 cfs.

APPENDIX C

HYDROLOGY AND HYDRAULIC CALCULATIONS

SUMMARY DESCRIPTION
OF
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION

The hydrologic and hydraulic evaluation for this inspection report has employed computer techniques using the Corps of Engineers computer program identified as the Flood Hydrograph Package (HEC-1) Dam Safety Version.

The program has been designed to enable the user to perform two basic types of hydrologic analyses: (1) the evaluation of the overtopping potential of the dam, and (2) the capability to estimate the downstream hydrologic-hydraulic consequences resulting from assumed structural failures of the dam. A brief summary of the computation procedures typically used in the dam overtopping analysis is shown below.

- Development of an inflow hydrograph to the reservoir.

- Routing of the inflow hydrograph(s) through the reservoir to determine if the event(s) analyzed would overtop the dam.

- Routing of the outflow hydrograph(s) of the reservoir to desired downstream locations. The results provide the peak discharge, time of the peak discharge and maximum stage of each routed hydrograph at the outlet of the reach.

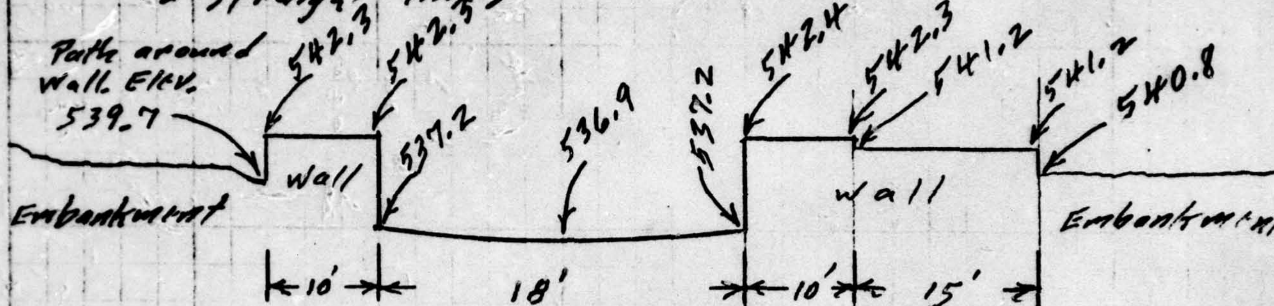
The output data provided by this program permits the comparison of downstream conditions just prior to a breach failure with that after a breach failure and the determination as to whether or not there is a significant increase in the hazard to loss of life as a result of such a failure.

The results of the studies conducted for this report are presented in Section 5.

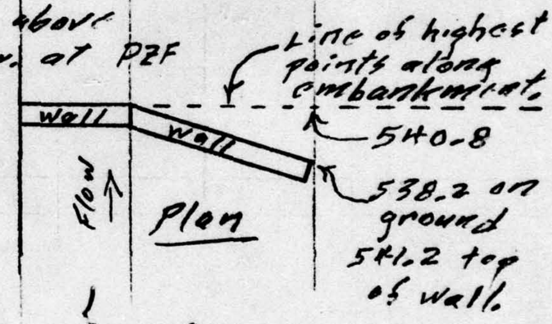
For detailed information regarding this program refer to the Users Manual for the Flood Hydrograph Package (HEC-1) Dam Safety Version prepared by the Hydrologic Engineering Center, U. S. Army Corps of Engineers, Davis, California.

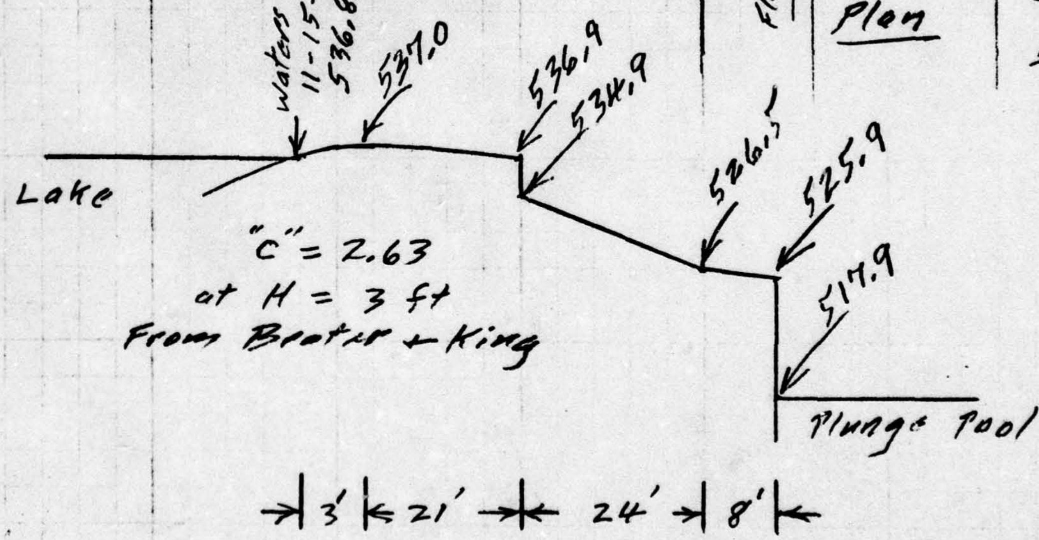
Spillway Rating

Profile along highest elevation. Not necessarily a straight line.



High point in spillway approach is 21 feet upstream from above cross section. Elev. at PZF (Point Zero Flow) = 537.0





"C" = 2.63
at H = 3 ft
From Brater + King

Top of embankment is uneven due to many paths

Lowest elev.	539.7	H = 2.7
Average elev.	541.4	H = 4.4
Highest elev.	542.3	H = 5.3

$$Q = CLH^{3/2} = 2.63 \times 18 \times (2.7)^{3/2} = 210 \text{ cfs}$$

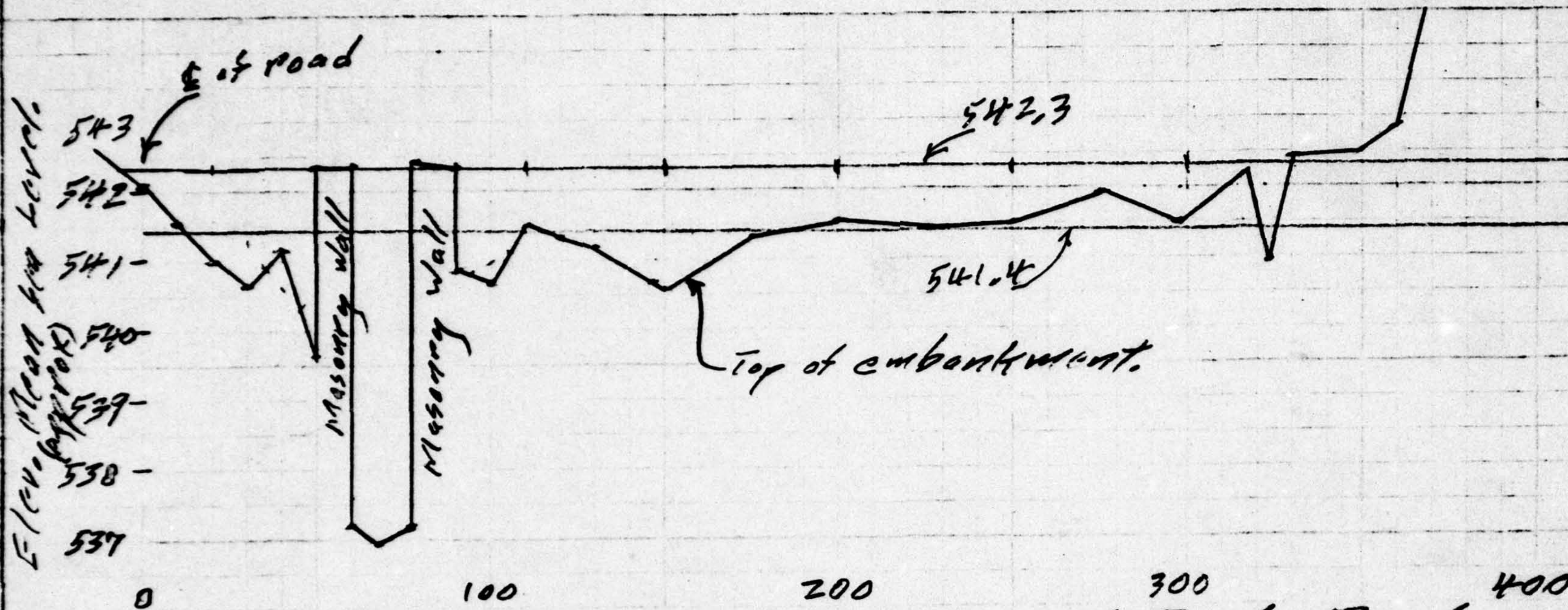
$$= 2.63 \times 18 \times (4.4)^{3/2} = 437 \text{ cfs}$$

$$= 2.63 \times 18 \times (5.3)^{3/2} = 578 \text{ cfs}$$

} Plus flow over embankment.

SUBJECT Stovers Lake
COMPUTED BY RES DATE 11-20-78
CHECKED BY JJP 11-29-78

Spillway Rating (cont).



Distance from centerline - Left Bank Road.

Use "C" = 2.67 for flow over embankment.

Pool at 541.4

$Q = CL(H)^{3/2}$

Flow over embankment:

$= 2.67 \times 17 \times (0.5)^{3/2} = 16$

$= 2.67 \times 20 \times (0.8)^{3/2} = 38$

$= 2.67 \times 18 \times (0.4)^{3/2} = 12$

$= 2.67 \times 65 \times (0.4)^{3/2} = 44$

$= 2.67 \times 4 \times (0.2)^{3/2} = 1$

Spillway 437

Total 548 cfs

Pool at 542.3

$Q = CL(H)^{3/2}$

$= 2.67 \times 25 \times (0.7)^{3/2} = 39$

$= 2.67 \times 30 \times (1.6)^{3/2} = 162$

$= 2.67 \times 20 \times (1.3)^{3/2} = 79$

$= 2.67 \times 40 \times (1.1)^{3/2} = 123$

$= 2.67 \times 50 \times (1.1)^{3/2} = 154$

$= 2.67 \times 50 \times (0.8)^{3/2} = 96$

$= 2.67 \times 50 \times 0.6)^{3/2} = 62$

$= 2.67 \times 30 \times (0.7)^{3/2} = 47$

Spillway 578

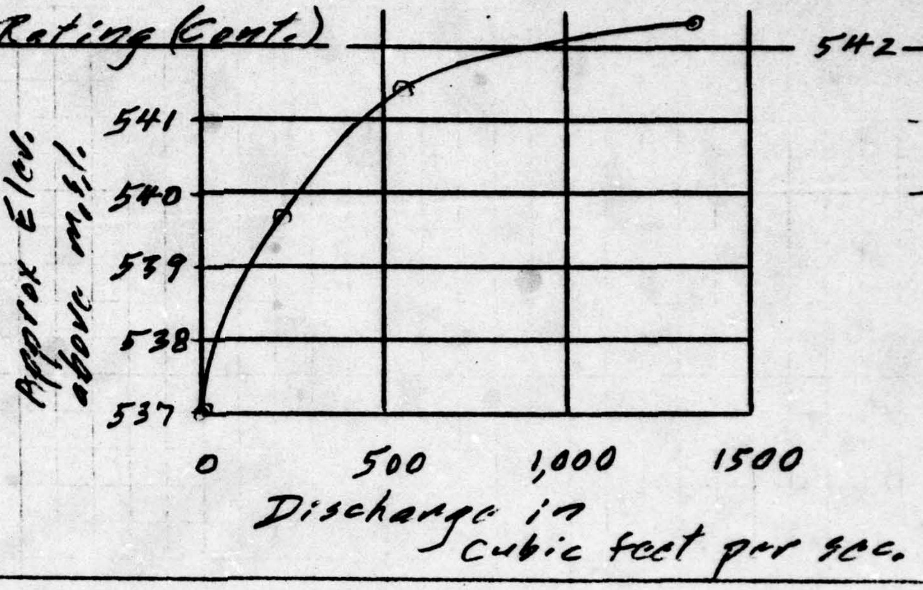
Total 1,340

Local resident said 1972 flood reached elev. of about 541.4 and held that level about two hours.

PROJECT Dam Investigation SHEET NO. 2 OF 6
SUBJECT Stovers Lake - I.D. - No. 600
COMPUTED BY RES DATE 11-20-78 CHECKED BY JJP 11-29-78

Spillway Rating (Cont.)

Indicated discharge includes flow over embankment.



Maximum Known Flood

Beck Creek is a nearby tributary to Quittapahilla Creek. For USGS gaging station Beck Creek near Cleona, the peak of record for period 1963 to 1978 was 5,150 cfs, June 22, 1972. Drainage Area is 7.87 sq. mi.

$$\left(\frac{1.1}{7.87}\right)^{.8} \times 5150 = 1{,}070 \text{ cfs}$$

Use 1,100 cfs for maximum known inflow to Storers Lake

Outlet works is a 12-inch cast-iron pipe with 12-inch gate valve at downstream end. Estimated length of pipe 125 feet.
" Upst. invert 517
" Downst. " 515

Pool at 520 $h = 520 - 515.5 = 4.5$ ft
$n = 0.02$

$$h = 2.87 \times (0.02)^2 \times \frac{125V^2}{1} + 0.5\frac{V^2}{2g} = 4.5$$

$$4.5 = V^2(0.1435 + 0.00778) = 0.1513V^2$$

$$V^2 = \frac{4.5}{0.1513} = 29.7, \quad V = 5.45$$

$$Q = VA = 5.45 \times \pi(.5)^2 = 4.28 \text{ cfs}$$

Use 4 cfs.

Outlet works (Cont.)

Pool at 537 $h = 537 - 515.5 = 21.5$ ft

$V^2 = \frac{21.5}{0.1513} = 142$, $V = 11.9$ ft/sec

$Q = VA = 11.9 \times \pi (.5)^2 = 9.35$ cfs

Use 9 cfs

BY RLS DATE 12/29/78 **BERGER ASSOCIATES** SHEET NO. 5 OF 8
CHKD. BY ______ DATE ______ PROJECT D8490
SUBJECT STOVERS DAM

TOP OF DAM RATING

POOL AT 543.5

$$Q = CLH^{3/2}$$
$= 2.67 \times 30 \times (1.9)^{3/2} = 210$
$= 2.67 \times 25 \times (1.9)^{3/2} = 175$
$= 2.67 \times 30 \times (2.8)^{3/2} = 375$
$= 2.67 \times 20 \times (2.5)^{3/2} = 211$
$= 2.67 \times 40 \times (2.3)^{3/2} = 372$
$= 2.67 \times 50 \times (2.3)^{3/2} = 466$
$= 2.67 \times 50 \times (2)^{3/2} = 377$
$= 2.67 \times 50 \times (1.8)^{3/2} = 322$
$= 2.63 \times 18 \times (6.5)^{3/2} = 784$
$= 2.67 \times 50 \times (1.2)^{3/2} = 175$

Total: 3467

POOL AT 545.5

$$Q = CLH^{3/2}$$
$= 2.67 \times 30 \times (3.9)^{3/2} = 617$
$= 2.67 \times 25 \times (3.9)^{3/2} = 514$
$= 2.67 \times 30 \times (4.8)^{3/2} = 842$
$= 2.67 \times 20 \times (4.5)^{3/2} = 509$
$= 2.67 \times 40 \times (4.3)^{3/2} = 952$
$= 2.67 \times 50 \times (4.3)^{3/2} = 1190$
$= 2.67 \times 50 \times (4)^{3/2} = 1068$
$= 2.67 \times 50 \times (3.8)^{3/2} = 989$
$= 2.63 \times 18 \times (8.5)^{3/2} = 1173$
$= 2.67 \times 50 \times (3.2)^{3/2} = 764$
$= 2.67 \times 14 \times (1)^{3/2} = 37$

Total: 8655

SIZE CLASSIFICATION

MAXIMUM STORAGE = 368 ACRE-FEET

MAXIMUM HEIGHT = 25 FEET

SIZE CLASSIFICATION IS SMALL

HAZARD CLASSIFICATION

SEVERAL HOUSES ARE LOCATED NEAR THE DOWNSTREAM CHANNEL

USE "HIGH"

RECOMMENDED SPILLWAY DESIGN FLOOD

THE ABOVE CLASSIFICATIONS INDICATE USE OF AN SDF EQUAL TO 1/2 THE PROBABLE MAXIMUM FLOOD TO THE PROBABLE MAXIMUM FLOOD.

HEC-1 DATA

DRAINAGE AREA = 1.1 SQ.MI.

SUSQUEHANNA BASIN REGION 15B

$C_P = .85$

$C_T = 2.20$

LONGEST WATER COURSE = 8800' = 1.67 mi.

L TO CENTROID = 4650' = .88 mi.

$$T_P = C_T (L \times L_{CA})^{.3}$$

$$T_P = 2.47$$

RAINFALL (HMR - 33)

INDEX (200 SQ.MI. - 24 HR.) = 23.2"

ZONE 6

INCREMENTAL RAINFALL

6 HR = 113 %
12 HR = 123 %
24 HR = 132 %
48 HR = 143 %

PLANIMETERED AREAS

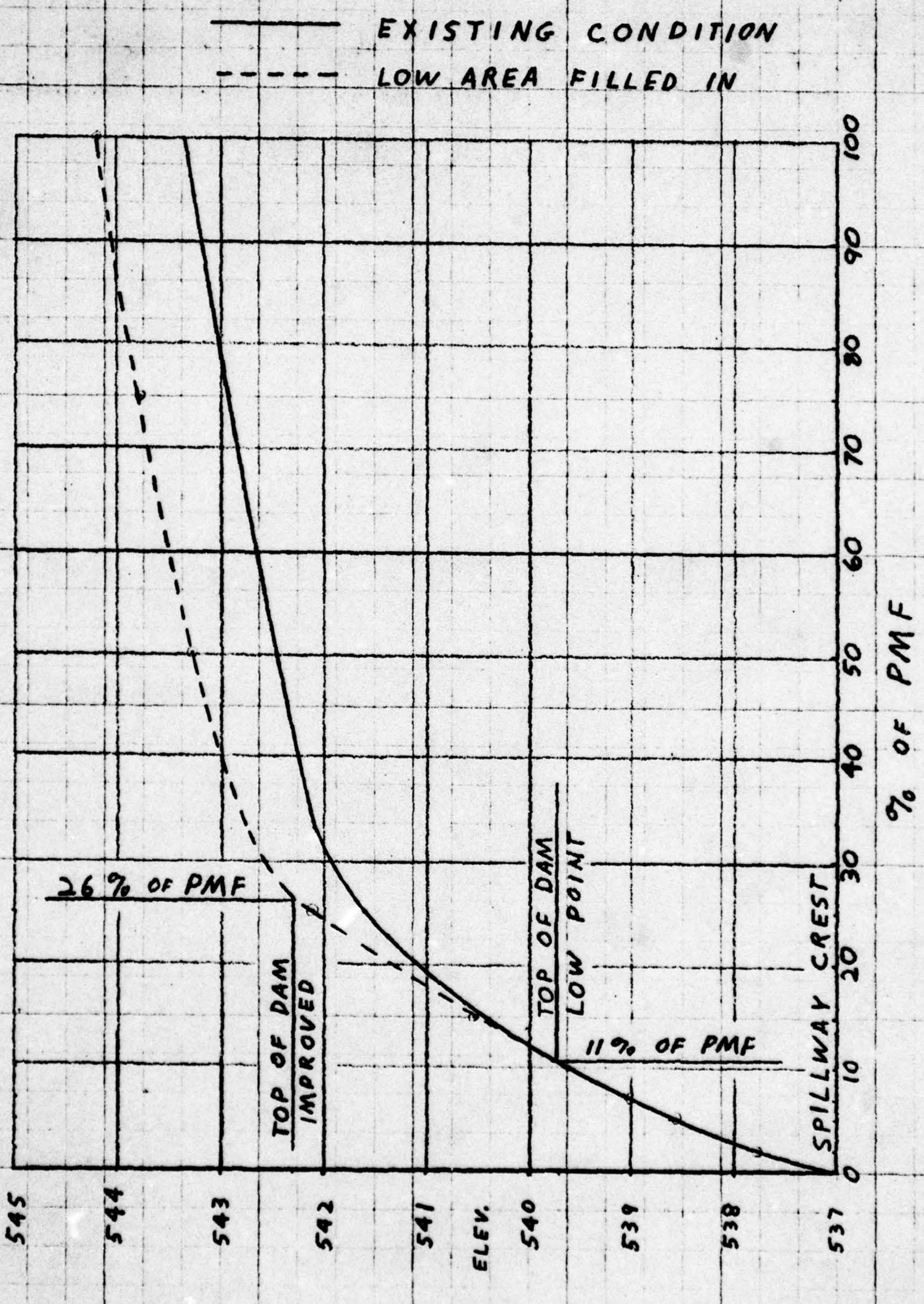
ELEV: 537 = 20 ACRES
540 = 31.2 ACRES
550 = 51.9 ACRES

ZERO STORAGE ELEVATION

ELEV. = 537 - (STORAGE × 3/AREA)
= 504.75

BY RLS DATE 1/3/79 BERGER ASSOCIATES SHEET NO. 9 OF 8
CHKD. BY ______ DATE ______ PROJECT D8490
SUBJECT STOVERS DAM

SPILLWAY CAPACITY CURVE



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FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION       JULY 1978
LAST MODIFICATION  21 AUG 78
*********************************
```

OVERTOPPING ANALYSIS

1/2

```
  1   A1    STOVERS DAM  ****  BRANCH OF BRANDYWINE CREEK
  2   A2    NORTH LEBANON TWP., LEBANON COUNTY, PA.
  3   A3    NDI # PA-00600    PA DER # 38-5
  4   B       300      0     15      0      0      0      0      0     -4      0
  5   B1        5
  6   J         1      9      1
  7   J1        1    .75     .5     .3    .15     .1    .07    .05    .02
  8   K                1                                      1
  9   K1                  INFLOW HYDROGRAPH
 10   M         1      1    1.1                                             1
 11   P             23.2    113    123    132    143
 12   T                                                       1    .05
 13   W      2.47    .85
 14   X      -1.5   -.05      2
 15   K         1      2                                      1
 16   K1                  RESERVOIR ROUTING
 17   Y                              1
 18   Y1        1                                           215     -1
 19   Y4      537  537.5    538  538.5    539  539.5    540  540.5    541  541.5
 20   Y4      542  542.3  543.5  545.5
 21   Y5        0     15     40     75    130    200    265    350    440    600
 22   Y5      900   1340   3467   8655
 23   $A        0     20   31.2   51.4
 24   $E504.75       537    540    550
 25   $$      537
 26   $D    539.7      0      0      0
 27   K         1      3                                      1
 28   K1                  REACH 2 - 3
 29   Y                              1      0
 30   Y1        1
 31   Y6      .06    .04    .06    515    540    350   .006
 32   Y7        0    530    200    520    800    517    801    515    810    515
 33   Y7      811    517    880    520   1050    540
 34   K         1      4
 35   K1                  REACH 3 - 4
 36   Y                              1      0
 37   Y1        1
 38   Y6      .06    .04    .06    512    540    300    .01
 39   Y7        0    530    250    520    830    514    831    512    840    512
 40   Y7      841    514    900    520   1100    540
 41   K        99
1                PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

                      RUNOFF HYDROGRAPH AT          1
                      ROUTE HYDROGRAPH TO           2
                      ROUTE HYDROGRAPH TO           3
                      ROUTE HYDROGRAPH TO           4
                      END OF NETWORK

1*********************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION       JULY 1978
LAST MODIFICATION  21 AUG 78
*********************************

RUN  DATE# 79/02/15.
     TIME# 05.40.41.
```

STOVERS DAM **** BRANCH OF BRANDYWINE CREEK
NORTH LEBANON TWP., LEBANON COUNTY, PA.
NDI # PA-00600 PA DER # 38-5

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
300	0	15	0	0	0	0	0	-4	0

JOPER	NWT	LROPT	TRACE
5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 9 LRTIO= 1
RTIOS= 1.00 .75 .50 .30 .15 .10 .07 .05 .02

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

INFLOW HYDROGRAPH

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
1	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	1.10	0.00	1.10	0.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	23.20	113.00	123.00	132.00	143.00	0.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS .800

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.00	.05	0.00	0.00

UNIT HYDROGRAPH DATA
TP= 2.47 CP= .85 NTA= 0

RECESSION DATA
STRTQ= -1.50 QRCSN= -.05 RTIOR= 2.00

UNIT HYDROGRAPH 24 END-OF-PERIOD ORDINATES, LAG= 2.46 HOURS, CP= .82 VOL= 1.00

11.	40.	74.	109.	141.	170.	197.	221.	238.	243.
239.	228.	212.	190.	161.	120.	80.	54.	36.	24.
16.	11.	7.	5.						

0 END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
									SUM	26.54	24.13	2.41	69096.
										(674.)	(613.)	(61.)	(1956.58)

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

HYDROGRAPH ROUTING

RESERVOIR ROUTING

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
2	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	0	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	215.	-1

STAGE	537.0	537.5	538.0	538.5	539.0	539.5	540.0	540.5	541.0	541.
	542.0	542.3	543.5	545.5						
FLOW	0.	15.	40.	75.	130.	200.	265.	350.	440.	600
	900.	1340.	3467.	8655.						

SURFACE AREA=	0.	20.	31.	51.
CAPACITY=	0.	215.	291.	700.
ELEVATION=	505.	537.	540.	550.

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
537.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
539.7	0.0	0.0	0.

PEAK OUTFLOW IS 3196. AT TIME 42.25 HOURS

PEAK OUTFLOW IS 2397. AT TIME 42.25 HOURS

PEAK OUTFLOW IS 1598. AT TIME 42.25 HOURS

PEAK OUTFLOW IS 858. AT TIME 42.75 HOURS

PEAK OUTFLOW IS 337. AT TIME 43.50 HOURS

PEAK OUTFLOW IS 214. AT TIME 43.50 HOURS

PEAK OUTFLOW IS 139. AT TIME 43.50 HOURS

PEAK OUTFLOW IS 89. AT TIME 43.75 HOURS

PEAK OUTFLOW IS 28. AT TIME 44.00 HOURS

HYDROGRAPH ROUTING

REACH 2 - 3

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
3	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	0	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	0.	0

NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELNVT	ELMAX	RLNTH	SEL
.0600	.0400	.0600	515.0	540.0	350.	.00600

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC

0.00	530.00	200.00	520.00	800.00	517.00	801.00	515.00	810.00	515.00
811.00	517.00	880.00	520.00	1050.00	540.00				

STORAGE	0.	0.	1.	4.	10.	17.	25.	34.	42.	51.
	61.	71.	81.	91.	102.	112.	123.	134.	144.	156.
OUTFLOW	0.	38.	163.	1052.	3708.	8875.	15851.	24515.	34807.	46696.
	60169.	75224.	92802.	112637.	134083.	157108.	181685.	207790.	235404.	264511.
STAGE	515.0	516.3	517.6	518.9	520.3	521.6	522.9	524.2	525.5	526.8
	528.2	529.5	530.8	532.1	533.4	534.7	536.1	537.4	538.7	540.0
FLOW	0.	38.	163.	1052.	3708.	8875.	15851.	24515.	34807.	46696.
	60169.	75224.	92802.	112637.	134083.	157108.	181685.	207790.	235404.	264511.

MAXIMUM STAGE IS 520.0

MAXIMUM STAGE IS 519.6

MAXIMUM STAGE IS 519.2

MAXIMUM STAGE IS 518.7

MAXIMUM STAGE IS 517.9

MAXIMUM STAGE IS 517.7

MAXIMUM STAGE IS 517.4

MAXIMUM STAGE IS 516.9

MAXIMUM STAGE IS 516.0

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HYDROGRAPH ROUTING

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
4	1	0	0	0	0	0	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	0	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	0.	0

NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELNVT	ELMAX	RLNTH	SEL
.0600	.0400	.0600	512.0	540.0	300.	.01000

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC

0.00	530.00	250.00	520.00	830.00	514.00	831.00	512.00	840.00	512.00
841.00	514.00	900.00	520.00	1100.00	540.00				

STORAGE	0.	0.	1.	2.	6.	11.	18.	25.	32.	41.
	49.	59.	68.	79.	89.	99.	110.	121.	132.	143.
OUTFLOW	0.	59.	267.	1278.	3780.	8316.	15943.	26557.	39632.	55164.
	73177.	93712.	116819.	145033.	176631.	210892.	247769.	287225.	329228.	373754.
STAGE	512.0	513.5	514.9	516.4	517.9	519.4	520.8	522.3	523.8	525.
	526.7	528.2	529.7	531.2	532.6	534.1	535.6	537.1	538.5	540.
FLOW	0.	59.	267.	1278.	3780.	8316.	15943.	26557.	39632.	55164.
	73177.	93712.	116819.	145033.	176631.	210892.	247769.	287225.	329228.	373754.

MAXIMUM STAGE IS 517.6

MAXIMUM STAGE IS 517.1

MAXIMUM STAGE IS 516.6

MAXIMUM STAGE IS 515.8

MAXIMUM STAGE IS 515.0

MAXIMUM STAGE IS 514.6

MAXIMUM STAGE IS 514.0

MAXIMUM STAGE IS 513.7

MAXIMUM STAGE IS 512.7

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PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

				RATIOS APPLIED TO FLOWS								
OPERATION	STATION	AREA	PLAN	RATIO 1 1.00	RATIO 2 .75	RATIO 3 .50	RATIO 4 .30	RATIO 5 .15	RATIO 6 .10	RATIO 7 .07	RATIO 8 .05	RATIO 9 .02
HYDROGRAPH AT	1	1.10	1	3228.	2421.	1614.	968.	484.	323.	226.	161.	65.
	(	2.85)	(	91.41)(	68.56)(	45.70)(	27.42)(	13.71)(	9.14)(	6.40)(	4.57)(	1.83)
ROUTED TO	2	1.10	1	3196.	2397.	1598.	858.	337.	214.	139.	89.	28.
	(	2.85)	(	90.49)(	67.88)(	45.24)(	24.30)(	9.53)(	6.06)(	3.92)(	2.53)(	.81
ROUTED TO	3	1.10	1	3197.	2397.	1599.	857.	337.	214.	139.	89.	28
	(	2.85)	(	90.52)(	67.88)(	45.28)(	24.27)(	9.54)(	6.06)(	3.92)(	2.52)(	.81
ROUTED TO	4	1.10	1	3198.	2400.	1595.	857.	337.	214.	139.	89.	28
	(	2.85)	(	90.55)(	67.95)(	45.16)(	24.26)(	9.54)(	6.06)(	3.92)(	2.52)(	.80

1 SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	537.00	537.00	539.70
STORAGE	215.	215.	282.
OUTFLOW	0.	0.	226.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	543.35	3.65	406.	3196.	11.00	42.25	0.00
.75	542.90	3.20	389.	2397.	10.00	42.25	0.00
.50	542.45	2.75	373.	1598.	8.75	42.25	0.00
.30	541.93	2.23	355.	858.	7.00	42.75	0.00
.15	540.42	.72	305.	337.	4.00	43.50	0.00
.10	539.61	0.00	279.	214.	0.00	43.50	0.00
.07	539.06	0.00	264.	139.	0.00	43.50	0.00
.05	538.63	0.00	252.	89.	0.00	43.75	0.00
.02	537.77	0.00	231.	28.	0.00	44.00	0.00

PLAN 1 STATION 3

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1.00	3197.	520.0	42.25
.75	2397.	519.6	42.25
.50	1599.	519.2	42.25
.30	857.	518.7	42.75
.15	337.	517.9	43.50
.10	214.	517.7	43.50
.07	139.	517.4	43.75
.05	89.	516.9	43.75
.02	28.	516.0	44.00

PLAN 1 STATION 4

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1.00	3198.	517.6	42.25
.75	2400.	517.1	42.25
.50	1595.	516.6	42.25
.30	857.	515.8	43.00
.15	337.	515.0	43.50
.10	214.	514.6	43.50
.07	139.	514.0	43.75
.05	89.	513.7	43.75
.02	28.	512.7	44.00

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1**********************************
 FLOOD HYDROGRAPH PACKAGE (HEC-1)
 DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  21 AUG 78
 **********************************
 EOI ENCOUNTERED.
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BREACH ANALYSIS

1/19

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FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
 LAST MODIFICATION  21 AUG 78
******************************
      1          A1      STOVERS DAM    ****  BRANCH OF BRANDYWINE CREEK
      2          A2      NORTH LEBANON TWP., LEBANON COUNTY, PA.
      3          A3      NDI # PA-00600    PA DER # 38-5
      4          B    300       0      15       0       0       0       0       0      -4       0
      5          B1     5
      6          J      5       1       1
      7          J1    .3
      8          K              1                                       1
      9          K1                  INFLOW HYDROGRAPH
     10          M      1       1     1.1                                               1
     11          P           23.2     113     123     132     143
     12          T                                                      1     .05
     13          W   2.47     .85
     14          X   -1.5    -.05       2
     15          K      1       2                                       1
     16          K1                  RESERVOIR ROUTING   -  DAM BREAK
     17          Y                              1       1
     18          Y1     1                                             215      -1
     19          Y4   537   537.5     538   538.5     539   539.5     540   540.5     541   541.5
     20          Y4   542   542.3   543.5   545.5
     21          Y5     0      15      40      75     130     200     265     350     440     600
     22          Y5   900    1340    3467    8655
     23          $A     0      20    31.2    51.4
     24          $E504.75     537     540     550
     25          $$   537
     26          $D 539.7       0       0       0
     27          $B    50       1     520     .25     537   541.9
     28          $B    50       1     520      .5     537   541.9
     29          $B    50       1     520       1     537   541.9
     30          $B    50       1     520       2     537   541.9
     31          $B    50       1     520       4     537   541.9
     32          K      1       3                                       1
     33          K1                   REACH 2 - 3
     34          Y                              1       1
     35          Y1     1
     36          Y6   .06     .04     .06     515     540     350    .006
     37          Y7     0     530     200     520     800     517     801     515     810     515
     38          Y7   811     517     880     520    1050     540
     39          K      1       4
     40          K1                   REACH 3 - 4
     41          Y                              1       1
     42          Y1     1
     43          Y6   .06     .04     .06     512     540     300     .01
     44          Y7     0     530     250     520     830     514     831     512     840     512
     45          Y7   841     514     900     520    1100     540
     46          K     99
1                          PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

                                 RUNOFF HYDROGRAPH AT          1
                                 ROUTE HYDROGRAPH TO           2
                                 ROUTE HYDROGRAPH TO           3
                                 ROUTE HYDROGRAPH TO           4
                                 END OF NETWORK

1******************************
 FLOOD HYDROGRAPH PACKAGE (HEC-1)
 DAM SAFETY VERSION      JULY 1978
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B
2/19

STOVERS DAM **** BRANCH OF BRANDYWINE CREEK
NORTH LEBANON TWP., LEBANON COUNTY, PA.
NDI # PA-00600 PA DER # 38-5

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
300	0	15	0	0	0	0	0	-4	0

JOPER	NWT	LROPT	TRACE
5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 5 NRTIO= 1 LRTIO= 1
RTIOS= .30

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

1NFLOW HYDROGRAPH

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
1	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	1.10	0.00	1.10	0.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	23.20	113.00	123.00	132.00	143.00	0.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS .800

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.00	.05	0.00	0.00

UNIT HYDROGRAPH DATA
TP= 2.47 CP= .85 NTA= 0

RECESSION DATA
STRTQ= -1.50 QRCSN= -.05 RTIOR= 2.00

UNIT HYDROGRAPH 24 END-OF-PERIOD ORDINATES, LAG= 2.46 HOURS, CP= .82 VOL= 1.00

11.	40.	74.	109.	141.	170.	197.	221.	238.	243.
239.	228.	212.	190.	161.	120.	80.	54.	36.	24.
16.	11.	7.	5.						

0 END-OF-PERIOD FLOW

MO.DA HR.MN PERIOD RAIN EXCS LOSS COMP Q MO.DA HR.MN PERIOD RAIN EXCS LOSS COMP (

SUM 26.54 24.13 2.41 69096
(674.)(613.)(61.)(1956.5

********** ********** ********** ********** **********

UNIT HYDROGRAPH 24 END-OF-PERIOD ORDINATES, LAG= 2.46 HOURS, CP= .82 VOL= 1.00

11.	40.	74.	109.	141.	170.	197.	221.	238.	243.
239.	228.	212.	190.	161.	120.	80.	54.	36.	24.
16.	11.	7.	5.						

0

END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
									SUM	26.54	24.13	2.41	69096.
										(674.)	(613.)	(61.)	(1956.58)

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HYDROGRAPH ROUTING

RESERVOIR ROUTING - DAM BREAK

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
2	1	0	0	0	0	1	0	0

ALL PLANS HAVE SAME
ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	215.	-1

STAGE	537.0	537.5	538.0	538.5	539.0	539.5	540.0	540.5	541.0	541.5
	542.0	542.3	543.5	545.5						
FLOW	0.	15.	40.	75.	130.	200.	265.	350.	440.	600.
	900.	1340.	3467.	8655.						

SURFACE AREA=	0.	20.	31.	51.
CAPACITY=	0.	215.	291.	700.
ELEVATION=	505.	537.	540.	550.

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
537.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
539.7	0.0	0.0	0.

DAM BREACH DATA

BRWID	Z	ELBM	TFAIL	WSEL	FAILEL
50.	1.00	520.00	.25	537.00	541.90

BEGIN DAM FAILURE AT 42.50 HOURS

PEAK OUTFLOW IS 14039. AT TIME 42.75 HOURS

THE DAM BREACH HYDROGRAPH WAS DEVELOPED USING A TIME INTERVAL OF .005 HOURS DURING BREACH FORMATION.
DOWNSTREAM CALCULATIONS WILL USE A TIME INTERVAL OF .250 HOURS.
THIS TABLE COMPARES THE HYDROGRAPH FOR DOWNSTREAM CALCULATIONS WITH THE COMPUTED BREACH HYDROGRAPH.
INTERMEDIATE FLOWS ARE INTERPOLATED FROM END-OF-PERIOD VALUES.

THIS TABLE COMPARES THE HYDROGRAPH FOR DOWNSTREAM CALCULATIONS WITH THE COMPUTED BREACH HYDROGRAPH.
INTERMEDIATE FLOWS ARE INTERPOLATED FROM END-OF-PERIOD VALUES.

6
4/19

TIME (HOURS)	TIME FROM BEGINNING OF BREACH (HOURS)	INTERPOLATED BREACH HYDROGRAPH (CFS)	-	COMPUTED BREACH HYDROGRAPH (CFS)	=	ERROR (CFS)	ACCUMULATED ERROR (CFS)	ACCUMULATED ERROR (AC-FT)
42.500	0.000	841.		841.		0.	0.	0.
42.505	.005	1105.		1509.		-404.	-404.	-0.
42.510	.010	1369.		1664.		-295.	-699.	-0.
42.515	.015	1633.		1829.		-196.	-895.	-0.
42.520	.020	1897.		2004.		-107.	-1002.	-0.
42.525	.025	2161.		2188.		-27.	-1029.	-0.
42.530	.030	2425.		2380.		45.	-984.	-0.
42.535	.035	2689.		2580.		109.	-875.	-0.
42.540	.040	2953.		2787.		166.	-709.	-0.
42.545	.045	3217.		3001.		216.	-493.	-0.
42.550	.050	3481.		3221.		260.	-233.	-0.
42.555	.055	3745.		3447.		298.	65.	0.
42.560	.060	4009.		3679.		330.	395.	0.
42.565	.065	4273.		3915.		357.	753.	0.
42.570	.070	4537.		4157.		380.	1133.	0.
42.575	.075	4801.		4402.		398.	1531.	1.
42.580	.080	5064.		4652.		412.	1943.	1.
42.585	.085	5328.		4910.		418.	2362.	1.
42.590	.090	5592.		5181.		412.	2773.	1.
42.595	.095	5856.		5455.		402.	3175.	1.
42.600	.100	6120.		5732.		388.	3563.	1.
42.605	.105	6384.		6013.		371.	3934.	2.
42.610	.110	6648.		6296.		352.	4287.	2.
42.615	.115	6912.		6581.		331.	4617.	2.
42.620	.120	7176.		6869.		307.	4925.	2.
42.625	.125	7440.		7161.		279.	5204.	2.
42.630	.130	7704.		7462.		242.	5446.	2.
42.635	.135	7968.		7764.		204.	5650.	2.
42.640	.140	8232.		8068.		164.	5814.	2.
42.645	.145	8496.		8372.		124.	5938.	2.
42.650	.150	8760.		8676.		83.	6021.	2.
42.655	.155	9024.		8981.		42.	6063.	3.
42.660	.160	9288.		9286.		1.	6065.	3.
42.665	.165	9552.		9590.		-39.	6026.	2.
42.670	.170	9816.		9893.		-78.	5948.	2.
42.675	.175	10079.		10196.		-116.	5832.	2.
42.680	.180	10343.		10499.		-156.	5676.	2.
42.685	.185	10607.		10799.		-191.	5485.	2.
42.690	.190	10871.		11094.		-222.	5262.	2.
42.695	.195	11135.		11382.		-247.	5015.	2.
42.700	.200	11399.		11664.		-265.	4750.	2.
42.705	.205	11663.		11939.		-276.	4474.	2.
42.710	.210	11927.		12208.		-280.	4194.	2.
42.715	.215	12191.		12471.		-280.	3914.	2.
42.720	.220	12455.		12724.		-269.	3644.	2.
42.725	.225	12719.		12972.		-253.	3392.	1.
42.730	.230	12983.		13211.		-228.	3164.	1.
42.735	.235	13247.		13437.		-190.	2974.	1.
42.740	.240	13511.		13652.		-142.	2832.	1.
42.745	.245	13775.		13852.		-77.	2755.	1.
42.750	.250	14039.		14039.		0.	2755.	1.

180VF8

STATION 2

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 TIME                        (O) INTERPOLATED BREACH HYDROGRAPH                                        B
 (HRS)                       (B) COMPUTED BREACH HYDROGRAPH                                          5/19
        0.     2000.     4000.     6000.     8000.    10000.    12000.    14000.    16000.        0.        0.        0.
42.50  1.  B      .         .         .         .         .         .         .         .         .         .         .
42.51  2.    O B  .         .         .         .         .         .         .         .         .         .         .
42.51  3.     OB  .         .         .         .         .         .         .         .         .         .         .
42.52  4.      OB .         .         .         .         .         .         .         .         .         .         .
42.52  5.       OB.         .         .         .         .         .         .         .         .         .         .
42.53  6.         .B        .         .         .         .         .         .         .         .         .         .
42.53  7.         . B       .         .         .         .         .         .         .         .         .         .
42.54  8.         .  B      .         .         .         .         .         .         .         .         .         .
42.54  9.         .   BO    .         .         .         .         .         .         .         .         .         .
42.55 10...............BO..................................................................................................
42.55 11.         .     BO  .         .         .         .         .         .         .         .         .         .
42.56 12.         .      B O.         .         .         .         .         .         .         .         .         .
42.56 13.         .       B O         .         .         .         .         .         .         .         .         .
42.57 14.         .        BO         .         .         .         .         .         .         .         .         .
42.57 15.         .         .B O      .         .         .         .         .         .         .         .         .
42.58 16.         .         . B O     .         .         .         .         .         .         .         .         .
42.58 17.         .         .  B O    .         .         .         .         .         .         .         .         .
42.59 18.         .         .   B O   .         .         .         .         .         .         .         .         .
42.59 19.         .         .    B O  .         .         .         .         .         .         .         .         .
42.60 20...........................B.O.................................................................................
42.60 21.         .         .        B.O        .         .         .         .         .         .         .         .
42.61 22.         .         .         B O       .         .         .         .         .         .         .         .
42.61 23.         .         .         .B O      .         .         .         .         .         .         .         .
42.62 24.         .         .         .  B O    .         .         .         .         .         .         .         .
42.62 25.         .         .         .   B O   .         .         .         .         .         .         .         .
42.63 26.         .         .         .     BO  .         .         .         .         .         .         .         .
42.63 27.         .         .         .      B O.         .         .         .         .         .         .         .
42.64 28.         .         .         .        BO         .         .         .         .         .         .         .
42.64 29.         .         .         .         BO        .         .         .         .         .         .         .
42.65 30...........................................B...................................................................
42.65 31.         .         .         .         .  BO     .         .         .         .         .         .         .
42.66 32.         .         .         .         .    B    .         .         .         .         .         .         .
42.66 33.         .         .         .         .     B   .         .         .         .         .         .         .
42.67 34.         .         .         .         .       B .         .         .         .         .         .         .
42.67 35.         .         .         .         .        B.         .         .         .         .         .         .
42.68 36.         .         .         .         .         OB        .         .         .         .         .         .
42.68 37.         .         .         .         .         . B       .         .         .         .         .         .
42.69 38.         .         .         .         .         .  OB     .         .         .         .         .         .
42.69 39.         .         .         .         .         .   OB    .         .         .         .         .         .
42.70 40.........................................................OB.....................................................
42.70 41.         .         .         .         .         .      OB .         .         .         .         .         .
42.71 42.         .         .         .         .         .       O B         .         .         .         .         .
42.71 43.         .         .         .         .         .         OB        .         .         .         .         .
42.72 44.         .         .         .         .         .         .OB       .         .         .         .         .
42.72 45.         .         .         .         .         .         . O B     .         .         .         .         .
42.73 46.         .         .         .         .         .         .   OB    .         .         .         .         .
42.73 47.         .         .         .         .         .         .    OB   .         .         .         .         .
42.74 48.         .         .         .         .         .         .     OB  .         .         .         .         .
42.74 49.         .         .         .         .         .         .       B .         .         .         .         .
42.75 50.....................................................................B.........................................
42.75 51.         .         .         .         .         .         .         B         .         .         .         .
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1OVN

DAM BREACH DATA

BRWID	Z	ELBM	TFAIL	WSEL	FAILEL
50.	1.00	520.00	.50	537.00	541.90

6/19

PEAK OUTFLOW IS 8934. AT TIME 42.97 HOURS

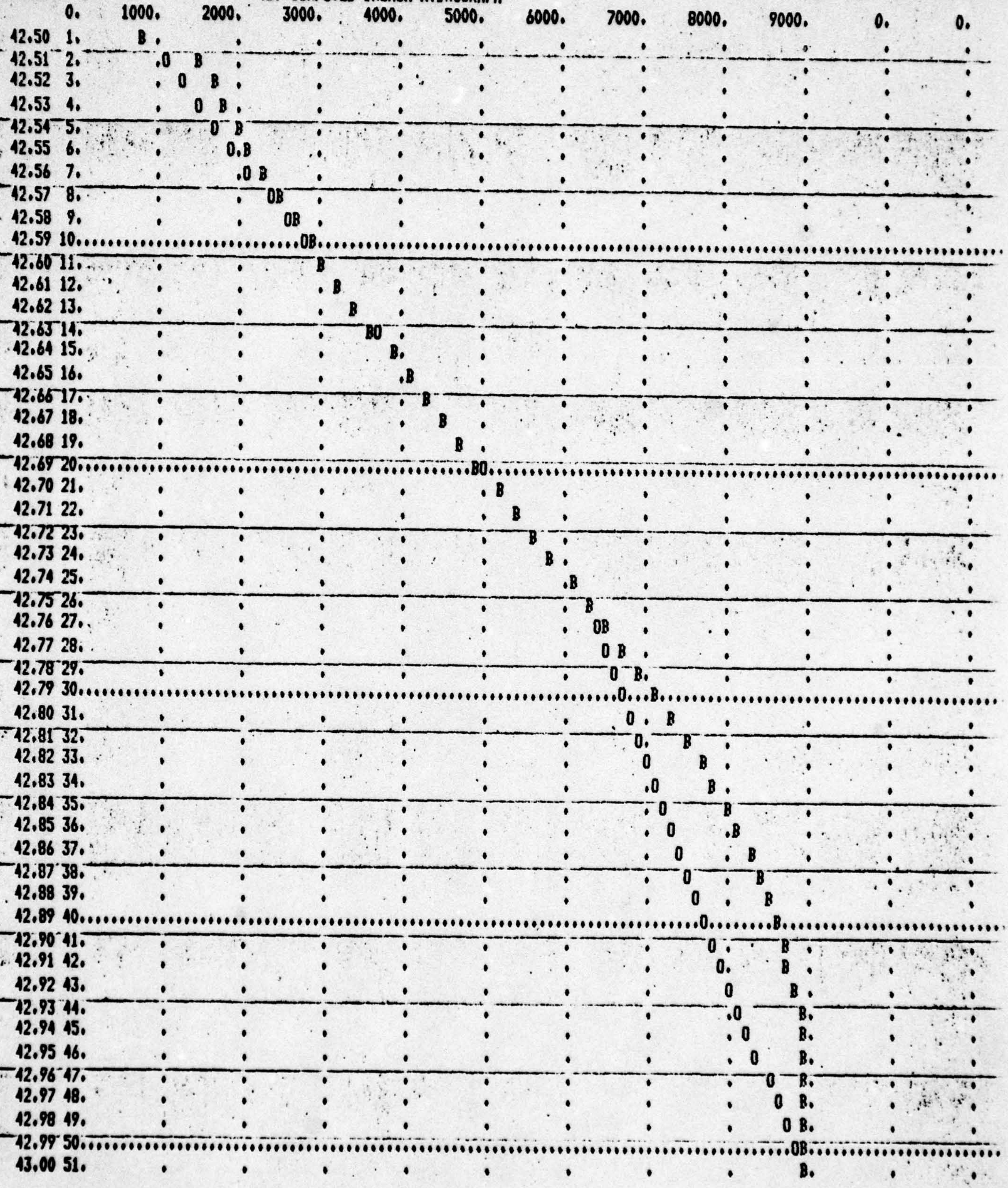
1THE DAM BREACH HYDROGRAPH WAS DEVELOPED USING A TIME INTERVAL OF .010 HOURS DURING BREACH FORMATION.
DOWNSTREAM CALCULATIONS WILL USE A TIME INTERVAL OF .250 HOURS.
THIS TABLE COMPARES THE HYDROGRAPH FOR DOWNSTREAM CALCULATIONS WITH THE COMPUTED BREACH HYDROGRAPH.
INTERMEDIATE FLOWS ARE INTERPOLATED FROM END-OF-PERIOD VALUES.

TIME (HOURS)	TIME FROM BEGINNING OF BREACH (HOURS)	INTERPOLATED BREACH HYDROGRAPH (CFS)	-	COMPUTED BREACH HYDROGRAPH (CFS)	=	ERROR (CFS)	ACCUMULATED ERROR (CFS)	ACCUMULATED ERROR (AC-FT)
42.500	0.000	841.		841.		0.	0.	0.
42.510	.010	1058.		1506.		-448.	-448.	-0.
42.520	.020	1275.		1653.		-377.	-825.	-1.
42.530	.030	1493.		1808.		-315.	-1140.	-1.
42.540	.040	1710.		1970.		-260.	-1401.	-1.
42.550	.050	1927.		2138.		-211.	-1612.	-1.
42.560	.060	2144.		2311.		-168.	-1779.	-1.
42.570	.070	2361.		2490.		-129.	-1908.	-2.
42.580	.080	2578.		2672.		-94.	-2002.	-2.
42.590	.090	2795.		2857.		-62.	-2064.	-2.
42.600	.100	3012.		3046.		-34.	-2098.	-2.
42.610	.110	3229.		3236.		-7.	-2105.	-2.
42.620	.120	3446.		3430.		16.	-2088.	-2.
42.630	.130	3663.		3641.		22.	-2066.	-2.
42.640	.140	3880.		3854.		27.	-2039.	-2.
42.650	.150	4097.		4068.		30.	-2010.	-2.
42.660	.160	4315.		4282.		32.	-1977.	-2.
42.670	.170	4532.		4497.		35.	-1943.	-2.
42.680	.180	4749.		4711.		38.	-1905.	-2.
42.690	.190	4966.		4935.		31.	-1874.	-2.
42.700	.200	5183.		5161.		22.	-1852.	-2.
42.710	.210	5400.		5386.		14.	-1838.	-2.
42.720	.220	5617.		5610.		7.	-1831.	-2.
42.730	.230	5834.		5831.		3.	-1828.	-2.
42.740	.240	6051.		6051.		-0.	-1828.	-2.
42.750	.250	6268.		6268.		0.	-1828.	-2.
42.760	.260	6372.		6482.		-110.	-1938.	-2.
42.770	.270	6476.		6695.		-218.	-2156.	-2.
42.780	.280	6580.		6904.		-323.	-2480.	-2.
42.790	.290	6684.		7105.		-421.	-2901.	-2.
42.800	.300	6788.		7298.		-510.	-3410.	-3.
42.810	.310	6892.		7481.		-589.	-3999.	-3.
42.820	.320	6997.		7654.		-658.	-4657.	-4.
42.830	.330	7101.		7822.		-722.	-5378.	-4.
42.840	.340	7205.		7978.		-774.	-6152.	-5.
42.850	.350	7309.		8128.		-819.	-6971.	-6.
42.860	.360	7413.		8265.		-853.	-7823.	-6.
42.870	.370	7517.		8391.		-874.	-8697.	-7.
42.880	.380	7621.		8500.		-879.	-9576.	-8.
42.890	.390	7725.		8596.		-871.	-10447.	-9.
42.900	.400	7829.		8673.		-845.	-11292.	-9.
42.910	.410	7933.		8745.		-812.	-12103.	-10.
42.920	.420	8037.		8805.		-768.	-12871.	-11.
42.930	.430	8141.		8854.		-713.	-13583.	-11.
42.940	.440	8245.		8891.		-646.	-14229.	-12.
42.950	.450	8349.		8917.		-568.	-14798.	-12.
42.960	.460	8453.		8932.		-478.	-15276.	-13.
42.970	.470	8557.		8934.		-377.	-15653.	-13.
42.980	.480	8661.		8925.		-263.	-15916.	-13.

B
7/19

TIME (HRS)

(O) INTERPOLATED BREACH HYDROGRAPH
(B) COMPUTED BREACH HYDROGRAPH



1DVN

DAM BREACH DATA

B
8/19

DAM BREACH DATA

BRWID	Z	ELBM	TFAIL	WSEL	FAILEL
50.	1.00	520.00	1.00	537.00	541.90

BEGIN DAM FAILURE AT 42.50 HOURS

PEAK OUTFLOW IS 5283. AT TIME 43.17 HOURS

THE DAM BREACH HYDROGRAPH WAS DEVELOPED USING A TIME INTERVAL OF .021 HOURS DURING BREACH FORMATION.
DOWNSTREAM CALCULATIONS WILL USE A TIME INTERVAL OF .250 HOURS.
THIS TABLE COMPARES THE HYDROGRAPH FOR DOWNSTREAM CALCULATIONS WITH THE COMPUTED BREACH HYDROGRAPH.
INTERMEDIATE FLOWS ARE INTERPOLATED FROM END-OF-PERIOD VALUES.

TIME (HOURS)	TIME FROM BEGINNING OF BREACH (HOURS)	INTERPOLATED BREACH HYDROGRAPH (CFS)	-	COMPUTED BREACH HYDROGRAPH (CFS)	=	ERROR (CFS)	ACCUMULATED ERROR (CFS)	ACCUMULATED ERROR (AC-FT)
42.500	0.000	841.		841.		0.	0.	0.
42.521	.021	1035.		1506.		-471.	-471.	-1.
42.542	.042	1229.		1643.		-413.	-884.	-2.
42.563	.063	1423.		1784.		-361.	-1245.	-2.
42.583	.083	1617.		1928.		-310.	-1555.	-3.
42.604	.104	1811.		2074.		-262.	-1817.	-3.
42.625	.125	2006.		2220.		-215.	-2032.	-3.
42.646	.146	2200.		2367.		-167.	-2199.	-4.
42.667	.167	2394.		2512.		-118.	-2318.	-4.
42.688	.188	2588.		2678.		-91.	-2408.	-4.
42.708	.208	2782.		2844.		-63.	-2471.	-4.
42.729	.229	2976.		3008.		-33.	-2504.	-4.
42.750	.250	3170.		3170.		0.	-2504.	-4.
42.771	.271	3315.		3330.		-16.	-2520.	-4.
42.792	.292	3460.		3502.		-43.	-2562.	-4.
42.813	.313	3604.		3670.		-65.	-2628.	-5.
42.833	.333	3749.		3833.		-83.	-2711.	-5.
42.854	.354	3894.		3991.		-97.	-2808.	-5.
42.875	.375	4039.		4144.		-105.	-2913.	-5.
42.896	.396	4184.		4291.		-107.	-3020.	-5.
42.917	.417	4329.		4437.		-108.	-3128.	-5.
42.938	.438	4474.		4574.		-100.	-3227.	-6.
42.958	.458	4619.		4698.		-79.	-3306.	-6.
42.979	.479	4764.		4809.		-45.	-3351.	-6.
43.000	.500	4909.		4909.		0.	-3351.	-6.
43.021	.521	4933.		4999.		-66.	-3417.	-6.
43.042	.542	4958.		5080.		-121.	-3538.	-6.
43.063	.563	4983.		5148.		-165.	-3703.	-6.
43.083	.583	5007.		5203.		-196.	-3899.	-7.
43.104	.604	5032.		5242.		-210.	-4109.	-7.
43.125	.625	5057.		5263.		-206.	-4315.	-7.
43.146	.646	5081.		5278.		-197.	-4512.	-8.
43.167	.667	5106.		5283.		-177.	-4689.	-8.
43.188	.688	5131.		5278.		-148.	-4837.	-8.
43.208	.708	5155.		5264.		-108.	-4945.	-9.
43.229	.729	5180.		5239.		-59.	-5004.	-9.
43.250	.750	5204.		5204.		0.	-5004.	-9.
43.271	.771	5116.		5161.		-44.	-5049.	-9.
43.292	.792	5028.		5108.		-80.	-5128.	-9.
43.313	.812	4940.		5046.		-106.	-5234.	-9.
43.333	.833	4852.		4976.		-124.	-5358.	-9.
43.354	.854	4764.		4897.		-133.	-5491.	-9.
43.375	.875	4676.		4810.		-135.	-5625.	-10.
43.396	.896	4588.		4716.		-129.	-5754.	-10.

9/19

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TIME                           (O) INTERPOLATED BREACH HYDROGRAPH
(HRS)                          (B) COMPUTED BREACH HYDROGRAPH
      500.     1000.     1500.     2000.     2500.     3000.     3500.     4000.     4500.     5000.     5500.        0.
42.50  1.       B  .         .         .         .         .         .         .         .         .         .         .
42.52  2.          .O        B         .         .         .         .         .         .         .         .         .
42.54  3.          .    O    .  B      .         .         .         .         .         .         .         .         .
42.56  4.          .       O .     B   .         .         .         .         .         .         .         .         .
42.58  5.          .         . O      B.         .         .         .         .         .         .         .         .
42.60  6.          .         .     O   .B        .         .         .         .         .         .         .         .
42.63  7.          .         .         O   B     .         .         .         .         .         .         .         .
42.65  8.          .         .         .   O  B  .         .         .         .         .         .         .         .
42.67  9.          .         .         .       O B         .         .         .         .         .         .         .
42.69 10...........................................O.B..................................................................
42.71 11.          .         .         .         .     OB  .         .         .         .         .         .         .
42.73 12.          .         .         .         .         B         .         .         .         .         .         .
42.75 13.          .         .         .         .         .  B      .         .         .         .         .         .
42.77 14.          .         .         .         .         .     OB  .         .         .         .         .         .
42.79 15.          .         .         .         .         .        OB         .         .         .         .         .
42.81 16.          .         .         .         .         .         . OB      .         .         .         .         .
42.83 17.          .         .         .         .         .         .    O  B .         .         .         .         .
42.85 18.          .         .         .         .         .         .       O B         .         .         .         .
42.87 19.          .         .         .         .         .         .         .O B      .         .         .         .
42.90 20...........................................................................O.B.................................
42.92 21.          .         .         .         .         .         .         .       O B         .         .         .
42.94 22.          .         .         .         .         .         .         .        .O.B       .         .         .
42.96 23.          .         .         .         .         .         .         .         .  O B    .         .         .
42.98 24.          .         .         .         .         .         .         .         .     OB  .         .         .
43.00 25.          .         .         .         .         .         .         .         .        B.         .         .
43.02 26.          .         .         .         .         .         .         .         .         OB        .         .
43.04 27.          .         .         .         .         .         .         .         .         O, B      .         .
43.06 28.          .         .         .         .         .         .         .         .         .O  B     .         .
43.08 29.          .         .         .         .         .         .         .         .         .O   B    .         .
43.10 30............................................................................................O...B..............
43.12 31.          .         .         .         .         .         .         .         .         .O   B   .         .
43.15 32.          .         .         .         .         .         .         .         .         . O   B  .         .
43.17 33.          .         .         .         .         .         .         .         .         . O   B  .         .
43.19 34.          .         .         .         .         .         .         .         .         .  O  B  .         .
43.21 35.          .         .         .         .         .         .         .         .         .  O B   .         .
43.23 36.          .         .         .         .         .         .         .         .         .   OB   .         .
43.25 37.          .         .         .         .         .         .         .         .         .   B    .         .
43.27 38.          .         .         .         .         .         .         .         .         . OB     .         .
43.29 39.          .         .         .         .         .         .         .         .         .OB      .         .
43.31 40..........................................................................................O.B..................
43.33 41.          .         .         .         .         .         .         .         .       O  B        .         .
43.35 42.          .         .         .         .         .         .         .         .     O  B.         .         .
43.37 43.          .         .         .         .         .         .         .         .    O B  .         .         .
43.40 44.          .         .         .         .         .         .         .         . O B .  .         .         .
43.42 45.          .         .         .         .         .         .         .         O B      .         .         .
43.44 46.          .         .         .         .         .         .         .       O B        .         .         .
43.46 47.          .         .         .         .         .         .         .     O B.         .         .         .
43.48 48.          .         .         .         .         .         .         .    B    .         .         .         .
43.50 49.          .         .         .         .         .         .         .  B      .         .         .         .
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1*OVN*

DAM BREACH DATA

BRWID	Z	ELBM	TFAIL	WSEL	FAILEL
50.	1.00	520.00	2.00	537.00	541.90

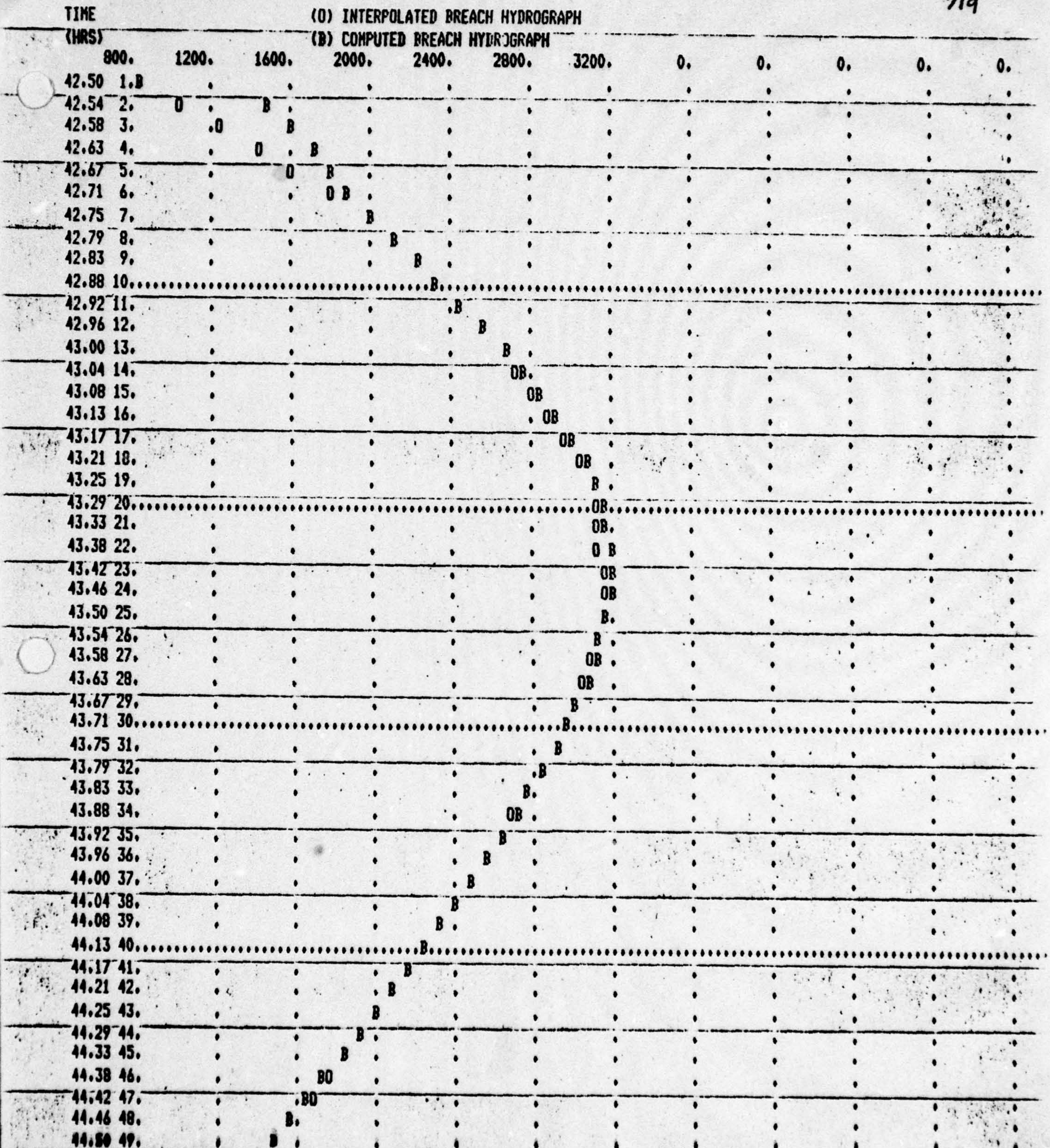
10/19

PEAK OUTFLOW IS 3191. AT TIME 43.42 HOURS

1THE DAM BREACH HYDROGRAPH WAS DEVELOPED USING A TIME INTERVAL OF .042 HOURS DURING BREACH FORMATION.
DOWNSTREAM CALCULATIONS WILL USE A TIME INTERVAL OF .250 HOURS.
THIS TABLE COMPARES THE HYDROGRAPH FOR DOWNSTREAM CALCULATIONS WITH THE COMPUTED BREACH HYDROGRAPH.
INTERMEDIATE FLOWS ARE INTERPOLATED FROM END-OF-PERIOD VALUES.

TIME (HOURS)	TIME FROM BEGINNING OF BREACH (HOURS)	INTERPOLATED BREACH HYDROGRAPH (CFS) -	COMPUTED BREACH HYDROGRAPH (CFS) =	ERROR (CFS)	ACCUMULATED ERROR (CFS)	ACCUMULATED ERROR (AC-FT)
42.500	0.000	841.	841.	0.	0.	0.
42.542	.042	1035.	1494.	-459.	-459.	-2.
42.583	.083	1228.	1599.	-371.	-830.	-3.
42.625	.125	1422.	1702.	-280.	-1110.	-4.
42.667	.167	1615.	1802.	-187.	-1297.	-4.
42.708	.208	1809.	1898.	-89.	-1386.	-5.
42.750	.250	2003.	2003.	0.	-1386.	-5.
42.792	.292	2112.	2119.	-7.	-1392.	-5.
42.833	.333	2222.	2229.	-7.	-1399.	-5.
42.875	.375	2332.	2333.	-1.	-1401.	-5.
42.917	.417	2442.	2446.	-4.	-1405.	-5.
42.958	.458	2551.	2557.	-6.	-1411.	-5.
43.000	.500	2661.	2661.	-0.	-1411.	-5.
43.042	.542	2736.	2758.	-22.	-1433.	-5.
43.083	.583	2811.	2846.	-36.	-1469.	-5.
43.125	.625	2885.	2931.	-46.	-1515.	-5.
43.167	.667	2960.	3006.	-46.	-1561.	-5.
43.208	.708	3035.	3066.	-31.	-1591.	-5.
43.250	.750	3110.	3110.	0.	-1591.	-5.
43.292	.792	3118.	3146.	-28.	-1620.	-6.
43.333	.833	3126.	3171.	-45.	-1664.	-6.
43.375	.875	3134.	3187.	-53.	-1717.	-6.
43.417	.917	3142.	3191.	-49.	-1766.	-6.
43.458	.958	3150.	3181.	-31.	-1797.	-6.
43.500	1.000	3158.	3158.	0.	-1797.	-6.
43.542	1.042	3116.	3133.	-17.	-1814.	-6.
43.583	1.083	3074.	3101.	-27.	-1841.	-6.
43.625	1.125	3032.	3062.	-29.	-1870.	-6.
43.667	1.167	2990.	3016.	-25.	-1895.	-7.
43.708	1.208	2948.	2964.	-15.	-1911.	-7.
43.750	1.250	2906.	2906.	0.	-1911.	-7.
43.792	1.292	2836.	2844.	-9.	-1920.	-7.
43.833	1.333	2765.	2778.	-14.	-1933.	-7.
43.875	1.375	2694.	2708.	-15.	-1948.	-7.
43.917	1.417	2623.	2635.	-12.	-1960.	-7.
43.958	1.458	2552.	2559.	-7.	-1967.	-7.
44.000	1.500	2481.	2481.	0.	-1967.	-7.
44.042	1.542	2398.	2401.	-2.	-1970.	-7.
44.083	1.583	2316.	2319.	-3.	-1973.	-7.
44.125	1.625	2234.	2237.	-3.	-1976.	-7.
44.167	1.667	2151.	2154.	-2.	-1978.	-7.
44.208	1.708	2069.	2070.	-1.	-1980.	-7.
44.250	1.750	1986.	1986.	0.	-1980.	-7.
44.292	1.792	1905.	1903.	2.	-1978.	-7.
44.333	1.833	1824.	1820.	4.	-1974.	-7.
44.375	1.875	1742.	1738.	4.	-1970.	-7.
44.417	1.917	1661.	1657.	4.	-1965.	-7.
44.458	1.958	1580.	1577.	3.	-1963.	-7.
44.500	2.000	1499.	1499.	0.	-1963.	-7.

11/19



DAM BREACH DATA

BRWID	Z	ELBM	TFAIL	WSEL	FAILEL
50.	1.00	520.00	4.00	537.00	541.90

BEGIN DAM FAILURE AT 42.50 HOURS

3
12/19

PEAK OUTFLOW IS 1988. AT TIME 43.58 HOURS

1THE DAM BREACH HYDROGRAPH WAS DEVELOPED USING A TIME INTERVAL OF .083 HOURS DURING BREACH FORMATION.
DOWNSTREAM CALCULATIONS WILL USE A TIME INTERVAL OF .250 HOURS.
THIS TABLE COMPARES THE HYDROGRAPH FOR DOWNSTREAM CALCULATIONS WITH THE COMPUTED BREACH HYDROGRAPH.
INTERMEDIATE FLOWS ARE INTERPOLATED FROM END-OF-PERIOD VALUES.

TIME (HOURS)	TIME FROM BEGINNING OF BREACH (HOURS)	INTERPOLATED BREACH HYDROGRAPH (CFS)	-	COMPUTED BREACH HYDROGRAPH (CFS)	=	ERROR (CFS)	ACCUMULATED ERROR (CFS)	ACCUMULATED ERROR (AC-FT)
42.500	0.000	841.		841.		0.	0.	0.
42.583	.083	1081.		1471.		-391.	-391.	-3.
42.667	.167	1320.		1518.		-198.	-589.	-4.
42.750	.250	1559.		1559.		0.	-589.	-4.
42.833	.333	1615.		1604.		11.	-578.	-4.
42.917	.417	1670.		1670.		0.	-578.	-4.
43.000	.500	1725.		1725.		0.	-578.	-4.
43.083	.583	1780.		1781.		-0.	-579.	-4.
43.167	.667	1836.		1842.		-6.	-585.	-4.
43.250	.750	1891.		1891.		0.	-585.	-4.
43.333	.833	1922.		1930.		-8.	-593.	-4.
43.417	.917	1952.		1960.		-8.	-601.	-4.
43.500	1.000	1983.		1983.		0.	-601.	-4.
43.583	1.083	1975.		1988.		-13.	-614.	-4.
43.667	1.167	1967.		1977.		-10.	-624.	-4.
43.750	1.250	1958.		1958.		0.	-624.	-4.
43.833	1.333	1927.		1936.		-9.	-633.	-4.
43.917	1.417	1895.		1904.		-10.	-643.	-4.
44.000	1.500	1863.		1863.		0.	-643.	-4.
44.083	1.583	1816.		1815.		0.	-642.	-4.
44.167	1.667	1768.		1770.		-2.	-644.	-4.
44.250	1.750	1721.		1721.		0.	-644.	-4.
44.333	1.833	1667.		1669.		-2.	-646.	-4.
44.417	1.917	1614.		1615.		-2.	-648.	-4.
44.500	2.000	1560.		1560.		0.	-648.	-4.
44.583	2.083	1503.		1503.		-0.	-648.	-4.
44.667	2.167	1446.		1446.		-0.	-648.	-4.
44.750	2.250	1389.		1389.		0.	-648.	-4.
44.833	2.333	1333.		1332.		1.	-648.	-4.
44.917	2.417	1276.		1276.		1.	-647.	-4.
45.000	2.500	1220.		1220.		0.	-647.	-4.
45.083	2.583	1166.		1164.		1.	-646.	-4.
45.167	2.667	1112.		1110.		1.	-645.	-4.
45.250	2.750	1058.		1058.		0.	-645.	-4.
45.333	2.833	1007.		1006.		1.	-644.	-4.
45.417	2.917	957.		956.		1.	-642.	-4.
45.500	3.000	907.		907.		0.	-642.	-4.
45.583	3.083	861.		859.		1.	-641.	-4.
45.667	3.167	815.		813.		1.	-640.	-4.
45.750	3.250	768.		768.		0.	-640.	-4.
45.833	3.333	727.		725.		2.	-638.	-4.
45.917	3.417	686.		684.		2.	-636.	-4.
46.000	3.500	645.		645.		0.	-636.	-4.
46.083	3.583	610.		608.		2.	-634.	-4.
46.167	3.667	575.		573.		2.	-632.	-4.
46.250	3.750	539.		539.		0.	-632.	-4.
46.333	3.833	510.		508.		2.	-630.	-4.
46.417	3.917	481.		479.		2.	-628.	-4.

STATION 2

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TIME                       (O) INTERPOLATED BREACH HYDROGRAPH
(HRS)                      (B) COMPUTED BREACH HYDROGRAPH
     400.      600.      800.     1000.     1200.     1400.     1600.     1800.     2000.        0.        0.        0.
42.50  1.         .         . B       .         .         .         .         .         .         .         .         .
42.58  2.         .         .         .   O     .         .   B     .         .         .         .         .         .
42.67  3.         .         .         .         .     O   .     B   .         .         .         .         .         .
42.75  4.         .         .         .         .         .       B .         .         .         .         .         .
42.83  5.         .         .         .         .         .         BO        .         .         .         .         .
42.92  6.         .         .         .         .         .         .  B      .         .         .         .         .
43.00  7.         .         .         .         .         .         .     B   .         .         .         .         .
43.08  8.         .         .         .         .         .         .        B.         .         .         .         .
43.17  9.         .         .         .         .         .         .         . B       .         .         .         .
43.25 10..........................................................................B.......................................
43.33 11.         .         .         .         .         .         .         .     OB  .         .         .         .
43.42 12.         .         .         .         .         .         .         .       B .         .         .         .
43.50 13.         .         .         .         .         .         .         .        B.         .         .         .
43.58 14.         .         .         .         .         .         .         .        B.         .         .         .
43.67 15.         .         .         .         .         .         .         .       OB.         .         .         .
43.75 16.         .         .         .         .         .         .         .       B .         .         .         .
43.83 17.         .         .         .         .         .         .         .     OB  .         .         .         .
43.92 18.         .         .         .         .         .         .         .    B    .         .         .         .
44.00 19.         .         .         .         .         .         .         .  B      .         .         .         .
44.08 20.......................................................................B...........................................
44.17 21.         .         .         .         .         .         .       OB.         .         .         .         .
44.25 22.         .         .         .         .         .         .     B   .         .         .         .         .
44.33 23.         .         .         .         .         .         .  B      .         .         .         .         .
44.42 24.         .         .         .         .         .         .B        .         .         .         .         .
44.50 25.         .         .         .         .         .       B .         .         .         .         .         .
44.58 26.         .         .         .         .         .    B    .         .         .         .         .         .
44.67 27.         .         .         .         .         . B       .         .         .         .         .         .
44.75 28.         .         .         .         .        B.         .         .         .         .         .         .
44.83 29.         .         .         .         .      B  .         .         .         .         .         .         .
44.92 30............................................B......................................................................
45.00 31.         .         .         .         .B        .         .         .         .         .         .         .
45.08 32.         .         .         .       B .         .         .         .         .         .         .         .
45.17 33.         .         .         .     B   .         .         .         .         .         .         .         .
45.25 34.         .         .         .  B      .         .         .         .         .         .         .         .
45.33 35.         .         .         B         .         .         .         .         .         .         .         .
45.42 36.         .         .       B .         .         .         .         .         .         .         .         .
45.50 37.         .         .    B    .         .         .         .         .         .         .         .         .
45.58 38.         .         .  B      .         .         .         .         .         .         .         .         .
45.67 39.         .         .B        .         .         .         .         .         .         .         .         .
45.75 40..................B................................................................................................
45.83 41.         .     B   .         .         .         .         .         .         .         .         .         .
45.92 42.         .   B     .         .         .         .         .         .         .         .         .         .
46.00 43.         . B       .         .         .         .         .         .         .         .         .         .
46.08 44.         B         .         .         .         .         .         .         .         .         .         .
46.17 45.        B.         .         .         .         .         .         .         .         .         .         .
46.25 46.      B  .         .         .         .         .         .         .         .         .         .         .
46.33 47.    BO   .         .         .         .         .         .         .         .         .         .         .
46.42 48.   B     .         .         .         .         .         .         .         .         .         .         .
46.50 49.  B      .         .         .         .         .         .         .         .         .         .         .
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B
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HYDROGRAPH ROUTING

REACH 2 - 3

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
3	1	0	0	0	0	1	0	0

ALL PLANS HAVE SAME
ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	0.	0

NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELNVT	ELMAX	RLNTH	SEL
.0600	.0400	.0600	515.0	540.0	350.	.00600

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC

0.00	530.00	200.00	520.00	800.00	517.00	801.00	515.00	810.00	515.00
811.00	517.00	880.00	520.00	1050.00	540.00				

STORAGE	0.	0.	1.	4.	10.	17.	25.	34.	42.	51.
	61.	71.	81.	91.	102.	112.	123.	134.	144.	156.
OUTFLOW	0.	38.	163.	1052.	3708.	8875.	15851.	24515.	34807.	46696.
	60169.	75224.	92802.	112637.	134083.	157108.	181685.	207790.	235404.	264511.
STAGE	515.0	516.3	517.6	518.9	520.3	521.6	522.9	524.2	525.5	526.9
	528.2	529.5	530.8	532.1	533.4	534.7	536.1	537.4	538.7	540.0
FLOW	0.	38.	163.	1052.	3708.	8875.	15851.	24515.	34807.	46696.
	60169.	75224.	92802.	112637.	134083.	157108.	181685.	207790.	235404.	264511.

MAXIMUM STAGE IS 522.2

MAXIMUM STAGE IS 521.6

MAXIMUM STAGE IS 520.6

MAXIMUM STAGE IS 520.0

MAXIMUM STAGE IS 519.4

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HYDROGRAPH ROUTING

REACH 3 - 4

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
4	1	0	0	0	0	0	0	0

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HYDROGRAPH ROUTING

REACH 3 - 4

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
4	1	0	0	0	0	0	0	0

ALL PLANS HAVE SAME
ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	0.	0

NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELNVT	ELMAX	RLNTH	SEL
.0600	.0400	.0600	512.0	540.0	300.	.01000

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC

0.00 530.00 250.00 520.00 830.00 514.00 831.00 512.00 840.00 512.00
841.00 514.00 900.00 520.00 1100.00 540.00

STORAGE	0.	0.	1.	2.	6.	11.	18.	25.	32.	41.
	49.	59.	68.	79.	89.	99.	110.	121.	132.	143.
OUTFLOW	0.	59.	267.	1278.	3780.	8316.	15943.	26557.	39632.	55164.
	73177.	93712.	116819.	145033.	176631.	210892.	247769.	287225.	329228.	373754.
STAGE	512.0	513.5	514.9	516.4	517.9	519.4	520.8	522.3	523.8	525.[illegible]
	526.7	528.2	529.7	531.2	532.6	534.1	535.6	537.1	538.5	540.[illegible]
FLOW	0.	59.	267.	1278.	3780.	8316.	15943.	26557.	39632.	55164.
	73177.	93712.	116819.	145033.	176631.	210892.	247769.	287225.	329228.	373754.

MAXIMUM STAGE IS 519.9

MAXIMUM STAGE IS 519.6

MAXIMUM STAGE IS 518.3

MAXIMUM STAGE IS 517.6

MAXIMUM STAGE IS 516.8

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PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 .30
HYDROGRAPH AT	1	1.10	1	968.
		(2.85)		(27.42)(
			2	968.
				(27.42)(
			3	968.
				(27.42)(
			4	968.
				(27.42)(
			5	968.
				(27.42)(
ROUTED TO	2	1.10	1	14039.
		(2.85)		(397.53)(
			2	8869.
				(251.15)(
			3	5204.
				(147.37)(
			4	3158.
				(89.43)(
			5	1983.
				(56.16)(
ROUTED TO	3	1.10	1	12276.
		(2.85)		(347.63)(
			2	9240.
				(261.64)(
			3	5131.
				(145.31)(
			4	3211.
				(90.93)(
			5	2011.
				(56.94)(
ROUTED TO	4	1.10	1	11127.
		(2.85)		(315.07)(
			2	9312.
				(263.70)(
			3	5159.
				(146.09)(
			4	3211.
				(90.91)(
			5	2002.
				(56.70)(

1 SUMMARY OF DAM SAFETY ANALYSIS

B
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SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	537.00	537.00	539.70
STORAGE	215.	215.	282.
OUTFLOW	0.	0.	226.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.30	541.90	2.20	354.	14039.	2.68	42.75	42.50

PLAN 2 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	537.00	537.00	539.70
STORAGE	215.	215.	282.
OUTFLOW	0.	0.	226.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.30	541.90	2.20	354.	8934.	2.78	42.97	42.50

PLAN 3 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	537.00	537.00	539.70
STORAGE	215.	215.	282.
OUTFLOW	0.	0.	226.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.30	541.90	2.20	354.	5283.	2.92	43.17	42.50

PLAN 4 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	537.00	537.00	539.70
STORAGE	215.	215.	282.
OUTFLOW	0.	0.	226.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.30	541.90	2.20	354.	3191.	3.13	43.42	42.50

PLAN 5 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	537.00	537.00	539.70
STORAGE	215.	215.	282.
OUTFLOW	0.	0.	226.

RATIO	MAXIMUM	MAXIMUM	MAXIMUM	MAXIMUM	DURATION	TIME OF	TIME OF

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.30	541.90	2.20	354.	3191.	3.13	43.42	42.50

PLAN 5 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	537.00	537.00	539.70
STORAGE	215.	215.	282.
OUTFLOW	0.	0.	226.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.30	541.90	2.20	354.	1988.	3.42	43.58	42.50

PLAN 1 STATION 3

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.30	12276.	522.2	42.75

PLAN 2 STATION 3

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.30	9240.	521.6	43.00

PLAN 3 STATION 3

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.30	5131.	520.6	43.25

PLAN 4 STATION 3

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.30	3211.	520.0	43.50

PLAN 5 STATION 3

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.30	2011.	519.4	43.50

PLAN 1 STATION 4

MAXIMUM MAXIMUM TIME

PLAN 4 STATION 3

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.30	3211.	520.0	43.50

PLAN 5 STATION 3

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.30	2011.	519.4	43.50

PLAN 1 STATION 4

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.30	11127.	519.9	42.75

PLAN 2 STATION 4

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.30	9312.	519.6	43.00

PLAN 3 STATION 4

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.30	5159.	518.3	43.25

PLAN 4 STATION 4

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.30	3211.	517.6	43.50

PLAN 5 STATION 4

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.30	2002.	516.8	43.50

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1**********************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  21 AUG 78
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EOI ENCOUNTERED.
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OVERTOPPING ANALYSIS
IMPROVED EMBANKMENT
1/7

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DAM SAFETY VERSION      JULY 1978
 LAST MODIFICATION  21 AUG 78
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  1        A1     STOVERS DAM    ****  BRANCH OF BRANDYWINE CREEK
  2        A2     NORTH LEBANON TWP., LEBANON COUNTY, PA.
  3        A3     NDI # PA-00600    PA DER # 38-5
  4        B    300       0      15       0       0       0       0       0      -4       0
  5        B1     5
  6        J      1       9       1
  7        J1     1     .75      .5     .25     .15      .1     .07     .05     .02
  8        K              1                                       1
  9        K1                  1NFLOW HYDROGRAPH
 10        M      1       1     1.1                                                       1
 11        P           23.2     113     123     132     143
 12        T                                                      1     .05
 13        W   2.47     .85
 14        X   -1.5    -.05       2
 15        K      1       2                                       1
 16        K1                  RESERVOIR ROUTING
 17        Y                              1
 18        Y1     1                                             215      00
 19        $A     0      20    31.2    51.4
 20        $E504.75     537     540     550
 21        $$   537      18    2.63     1.5
 22        $D 542.3     2.7     1.5     322
 23        K      1       3                                       1
 24        K1                    REACH 2 - 3
 25        Y                              1       0
 26        Y1     1
 27        Y6   .06     .04     .06     515     540     350    .006
 28        Y7     0     530     200     520     800     517     801     515     810     515
 29        Y7   811     517     880     520    1050     540
 30        K      1       4
 31        K1                    REACH 3 - 4
 32        Y                              1       0
 33        Y1     1
 34        Y6   .06     .04     .06     512     540     300     .01
 35        Y7     0     530     250     520     830     514     831     512     840     512
 36        Y7   841     514     900     520    1100     540
 37        K     99
1                             PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

                                   RUNOFF HYDROGRAPH AT            1
                                   ROUTE HYDROGRAPH TO             2
                                   ROUTE HYDROGRAPH TO             3
                                   ROUTE HYDROGRAPH TO             4
                                   END OF NETWORK

1**********************************
 FLOOD HYDROGRAPH PACKAGE (HEC-1)
 DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  21 AUG 78
**********************************

 RUN  DATE* 79/01/03.
      TIME* 09.36.37.

                             STOVERS DAM   ****  BRANCH OF BRANDYWINE CREEK
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STOVERS DAM **** BRANCH OF BRANDYWINE CREEK
NORTH LEBANON TWP., LEBANON COUNTY, PA.
NDI # PA-00600 PA DER # 38-5

2/7

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
300	0	15	0	0	0	0	0	-4	0

JOPER	NWT	LROPT	TRACE
5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 9 LRTIO= 1
RTIOS= 1.00 .75 .50 .25 .15 .10 .07 .05 .02

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SUB-AREA RUNOFF COMPUTATION

INFLOW HYDROGRAPH

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
1	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	1.10	0.00	1.10	0.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	23.20	113.00	123.00	132.00	143.00	0.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS .800

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.00	.05	0.00	0.00

UNIT HYDROGRAPH DATA
TP= 2.47 CP= .85 NTA= 0

RECESSION DATA
STRTQ= -1.50 QRCSN= -.05 RTIOR= 2.00

UNIT HYDROGRAPH 24 END-OF-PERIOD ORDINATES, LAG= 2.46 HOURS, CP= .82 VOL= 1.00

11.	40.	74.	109.	141.	170.	197.	221.	238.	243.
239.	228.	212.	190.	161.	120.	80.	54.	36.	24.
16.	11.	7.	5.						

0

END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
									SUM	26.54	24.13	2.41	69096.
										(674.)	(613.)	(61.)	(1956.58)

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HYDROGRAPH ROUTING

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

RESERVOIR ROUTING

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
2	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	0	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	215.	0

SURFACE AREA=	0.	20.	31.	51.
CAPACITY=	0.	215.	291.	700.
ELEVATION=	505.	537.	540.	550.

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
537.0	18.0	2.6	1.5	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
542.3	2.7	1.5	322.

PEAK OUTFLOW IS 3198. AT TIME 42.25 HOURS

PEAK OUTFLOW IS 2395. AT TIME 42.25 HOURS

PEAK OUTFLOW IS 1577. AT TIME 42.25 HOURS

PEAK OUTFLOW IS 545. AT TIME 43.50 HOURS

PEAK OUTFLOW IS 314. AT TIME 43.50 HOURS

PEAK OUTFLOW IS 203. AT TIME 43.50 HOURS

PEAK OUTFLOW IS 137. AT TIME 43.50 HOURS

PEAK OUTFLOW IS 94. AT TIME 43.75 HOURS

PEAK OUTFLOW IS 32. AT TIME 44.00 HOURS

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

REACH 2 - 3

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
3	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	0	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	0.	0

NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELNVT	ELMAX	RLNTH	SEL
.0600	.0400	.0600	515.0	540.0	350.	.00600

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC

0.00	530.00	200.00	520.00	800.00	517.00	801.00	515.00	810.00	515.00
811.00	517.00	880.00	520.00	1050.00	540.00				

STORAGE	0.	0.	1.	4.	10.	17.	25.	34.	42.	51
	61.	71.	81.	91.	102.	112.	123.	134.	144.	156
OUTFLOW	0.	38.	163.	1052.	3708.	8875.	15851.	24515.	34807.	46696
	60169.	75224.	92802.	112637.	134083.	157108.	181685.	207790.	235404.	264511
STAGE	515.0	516.3	517.6	518.9	520.3	521.6	522.9	524.2	525.5	526.
	528.2	529.5	530.8	532.1	533.4	534.7	536.1	537.4	538.7	540.
FLOW	0.	38.	163.	1052.	3708.	8875.	15851.	24515.	34807.	4669
	60169.	75224.	92802.	112637.	134083.	157108.	181685.	207790.	235404.	264511

MAXIMUM STAGE IS 520.0

MAXIMUM STAGE IS 519.6

MAXIMUM STAGE IS 519.2

MAXIMUM STAGE IS 518.2

MAXIMUM STAGE IS 517.9

MAXIMUM STAGE IS 517.7

MAXIMUM STAGE IS 517.4

MAXIMUM STAGE IS 516.9

MAXIMUM STAGE IS 516.1

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

REACH 3 - 4

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
4	1	0	0	0	0	0	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	0	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	0.	0

NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELNVT	ELMAX	RLNTH	SEL
.0600	.0400	.0600	512.0	540.0	300.	.01000

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC

0.00	530.00	250.00	520.00	830.00	514.00	831.00	512.00	840.00	512.00
841.00	514.00	900.00	520.00	1100.00	540.00				

STORAGE	0.	0.	1.	2.	6.	11.	18.	25.	32.	41.
	49.	59.	68.	79.	89.	99.	110.	121.	132.	143.
OUTFLOW	0.	59.	267.	1278.	3780.	8316.	15943.	26557.	39632.	55164.
	73177.	93712.	116819.	145033.	176631.	210892.	247769.	287225.	329228.	373754.
STAGE	512.0	513.5	514.9	516.4	517.9	519.4	520.8	522.3	523.8	525.3
	526.7	528.2	529.7	531.2	532.6	534.1	535.6	537.1	538.5	540.0
FLOW	0.	59.	267.	1278.	3780.	8316.	15943.	26557.	39632.	55164.
	73177.	93712.	116819.	145033.	176631.	210892.	247769.	287225.	329228.	373754.

MAXIMUM STAGE IS 517.6

MAXIMUM STAGE IS 517.1

MAXIMUM STAGE IS 516.6

MAXIMUM STAGE IS 515.4

MAXIMUM STAGE IS 515.0

MAXIMUM STAGE IS 514.5

MAXIMUM STAGE IS 514.0

MAXIMUM STAGE IS 513.7

MAXIMUM STAGE IS 512.8

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1

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

RATIOS APPLIED TO FLOWS

OPERATION	STATION	AREA	PLAN	RATIO 1 1.00	RATIO 2 .75	RATIO 3 .50	RATIO 4 .25	RATIO 5 .15	RATIO 6 .10	RATIO 7 .07	RATIO 8 .05	RATIO 9 .02
HYDROGRAPH AT	1	1.10	1	3228.	2421.	1614.	807.	484.	323.	226.	161.	65.
	(	2.85)	(	91.41)(	68.56)(	45.70)(	22.85)(	13.71)(	9.14)(	6.40)(	4.57)(	1.83)
ROUTED TO	2	1.10	1	3198.	2395.	1577.	545.	314.	203.	137.	94.	32.
	(	2.85)	(	90.57)(	67.82)(	44.66)(	15.44)(	8.89)(	5.73)(	3.87)(	2.65)(	.90)
ROUTED TO	3	1.10	1	3200.	2396.	1574.	545.	314.	202.	137.	94.	32.
	(	2.85)	(	90.60)(	67.84)(	44.57)(	15.44)(	8.88)(	5.73)(	3.87)(	2.65)(	.90)
ROUTED TO	4	1.10	1	3202.	2396.	1578.	545.	313.	202.	137.	94.	32.
	(	2.85)	(	90.67)(	67.84)(	44.70)(	15.44)(	8.88)(	5.73)(	3.87)(	2.65)(	.90)

1

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	537.00	537.00	542.30
STORAGE	215.	215.	368.
OUTFLOW	0.	0.	578.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	544.20	1.90	439.	3198.	6.25	42.25	0.00
.75	543.78	1.48	422.	2395.	5.25	42.25	0.00
.50	543.27	.97	403.	1577.	4.00	42.25	0.00
.25	542.10	0.00	361.	545.	0.00	43.50	0.00
.15	540.53	0.00	308.	314.	0.00	43.50	0.00
.10	539.64	0.00	280.	203.	0.00	43.50	0.00
.07	539.03	0.00	263.	137.	0.00	43.50	0.00
.05	538.57	0.00	251.	94.	0.00	43.75	0.00
.02	537.77	0.00	231.	32.	0.00	44.00	0.00

PLAN 1 STATION 3

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1.00	3200.	520.0	42.25
.75	2396.	519.6	42.25
.50	1574.	519.2	42.50
.25	545.	518.2	43.50
.15	314.	517.9	43.50
.10	202.	517.7	43.50
.07	137.	517.4	43.75
.05	94.	516.9	43.75
.02	32.	516.1	44.00

PLAN 1 STATION 4

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1.00	3202.	517.6	42.25
.75	2396.	517.1	42.25
.50	1578.	516.6	42.25
.25	545.	515.4	43.50
.15	313.	515.0	43.50
.10	[illegible]	514.5	[illegible]
.07	137.	514.0	43.75
.05	94.	513.7	43.75
.02	32.	512.8	44.00

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1**********************************
 FLOOD HYDROGRAPH PACKAGE (HEC-1)
 DAM SAFETY VERSION      JULY 1978
   LAST MODIFICATION  21 AUG 78
 **********************************
 EOI ENCOUNTERED.
N>
IDLE.
N>
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TABLE NO.1

COMPARISON OF WATER SURFACE ELEVATIONS

STOVERS DAM

PMF = 3,230 cfs

Crest Elevation - 542.3 Low Point - 539.7 Spillway Elevation - 537.0

	STAGE	CREST OF DAM ELEVATION	CREST OF DAM DEPTH	750' D/S OF DAM* APPROXIMATE ELEVATION
A.	At Low Point in Embankment Crest	539.7	0	514.7
B.	30% PMF Overtopping No Breach	541.93	2.23	515.8
C.	30% PMF Overtopping (15 Min. Breach)	541.9	2.20	519.9
D.	30% PMF Overtopping (2 Hour Breach)	541.9	2.20	517.6

*Several houses located about 750 feet downstream of Stovers Dam.

Condition C: (Time refers to elapsed time after start of storm).
Time to reach breach elevation 541.9 at dam = 42.5 Hours.
Water level 750' downstream at 42.5 Hours = 515.8.
Duration of breach = 15 Minutes.
Time for Breach to peak 750' downstream = .25 Hours.
Peak elevation 750' downstream due to breach = 519.9.
Rate of increase in water level = 4.1' in 15 Minutes.

APPENDIX D

GEOLOGIC REPORT

GEOLOGIC REPORT

Bedrock - dam and Reservoir

Formation Name: Martinsburg Formation.

Lithology: Medium gray to dark gray shale, weathers to light gray or light tan. Locally interbedded with argillaceous sandstone, red shale and thin bedded argillaceous limestone. No limestone has been mapped in the vicinity of the dam, but outcrops are scarce and no boring information is available.

Structure

The beds at the dam are in the lower limb of the Lebanon Valley nappe, a complex fold and fault structure. The bedding generally dips south at about 20° to 30°, but is often obscured by cleavage, especially in the Martinsburg Formation. Thrust faulting is common, and one fault is mapped just south of the dam. Air photo fracture traces trend N20° to 30°E and N85°W.

Overburden

No core boring information is available for this dam, which was originally built in 1820. The overburden in this area consists of weathered shale, which is commonly 10 to 30 feet thick. Alluvium in the valleys of small creeks such as the Brandywine generally consists of silt and clay with minor sand and gravel.

Aquifer Characteristics

The Martinsburg shale is an essentially impermeable rock and ground water movement is along secondary fractures, joints and cleavage. The upper weathered zone is usually quite permeable, and in the unweathered shale major fracture zones can also be quite permeable.

Discussion

This dam has a long history of leakage at the toe of the embankment. No foundation information is available, and it is possible that no cutoff trench of any kind was ever made. It is likely therefore, that much of this leakage is through the weathered zone in the shale. There is no indication that the leakage has increased with time, and it is unlikely that the leakage would noticeably accelerate the weathering of the shale. The leakage therefore, probably does not represent a threat to the dam.

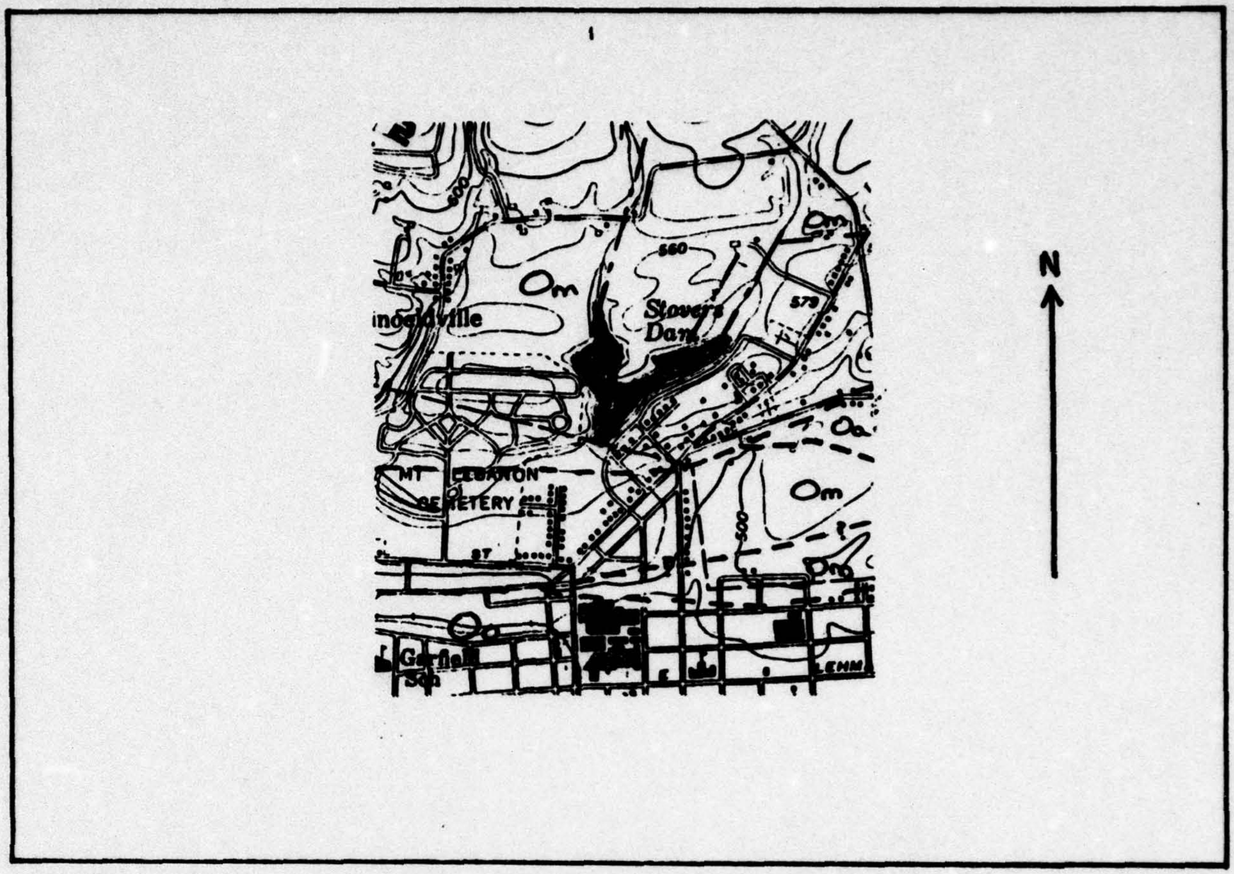
Sources of Information

1. Geyer, A.R., and Gray, C., et al. (1958) "Geology of the Lebanon Quadrangle". Pa. Geological Survey, Atlas 167C.

2. Air Photographs, scale 1:24,000, dated 1969.

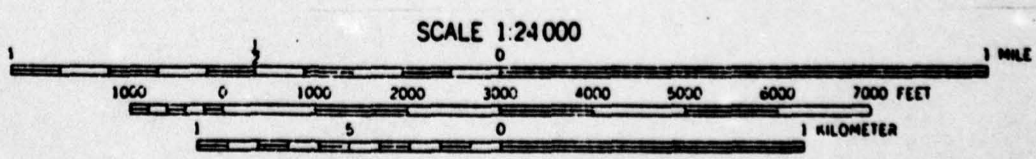
3. Inspection reports in file.

GEOLOGIC MAP - Stovers Dam



(geology from Pa. Geol. Survey, Atlas 167C)

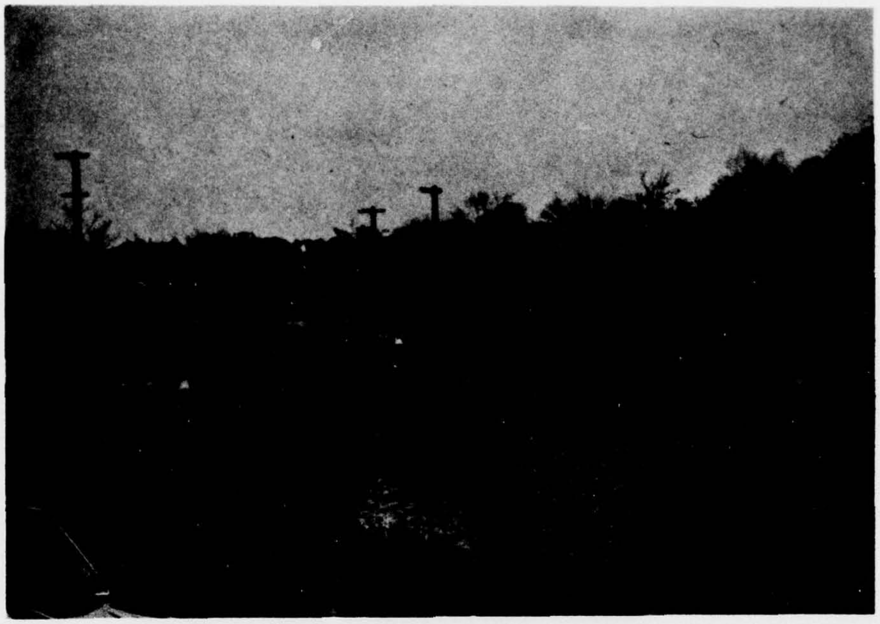
Om	Martinsburg Shale.
Oa	Annville l.s.
Oo	Ontelaunee Fm
— — — —	thrust fault
—·—·—	air photo fracture trace



CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
IS MEAN SEA LEVEL

APPENDIX E

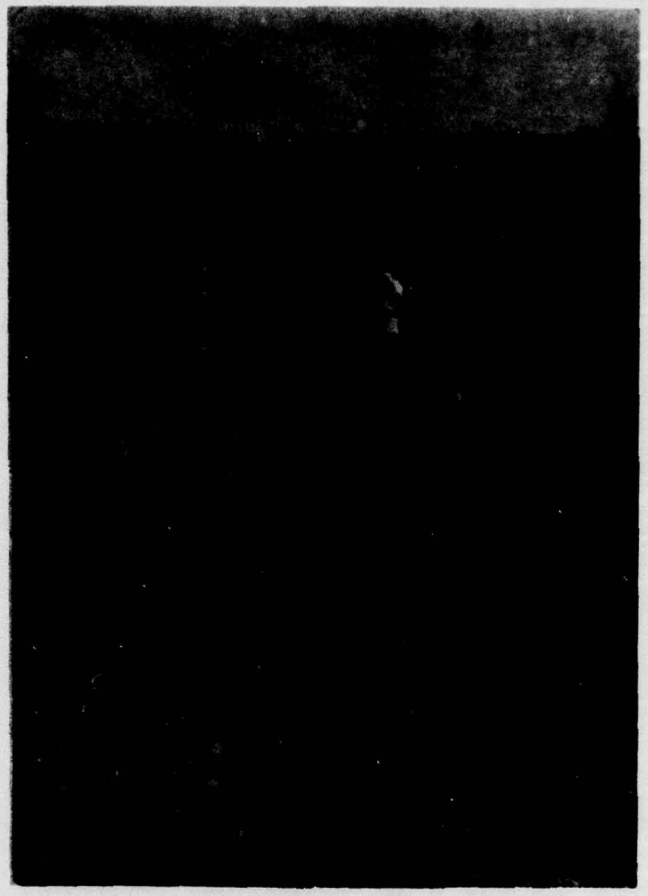
PHOTOGRAPHS



Spillway Apron & Dam Crest

Dam Crest at Right Abutment

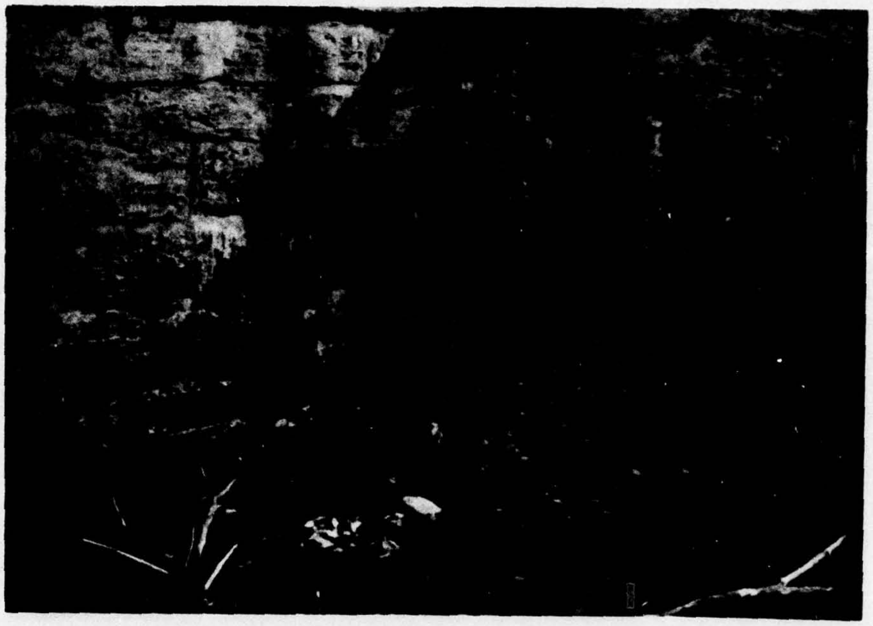
PA-600
PLATE E-I



Valve Chamber

Spillway & Plunge Pool

PA-600
PLATE E-II



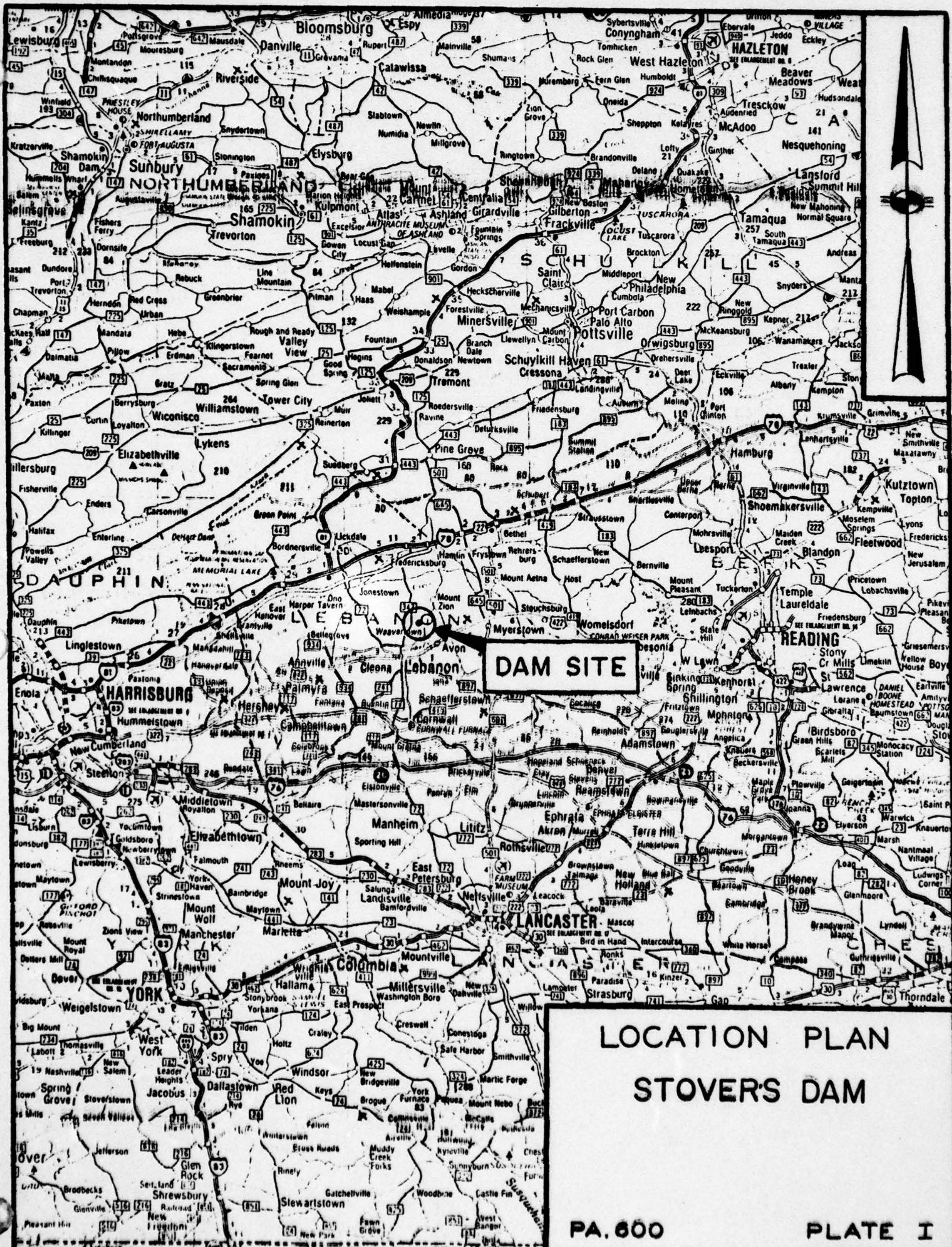
Seepage in Spillway Walls

Downstream Channel & 12-Inch Pipe

PA-600
PLATE E-III

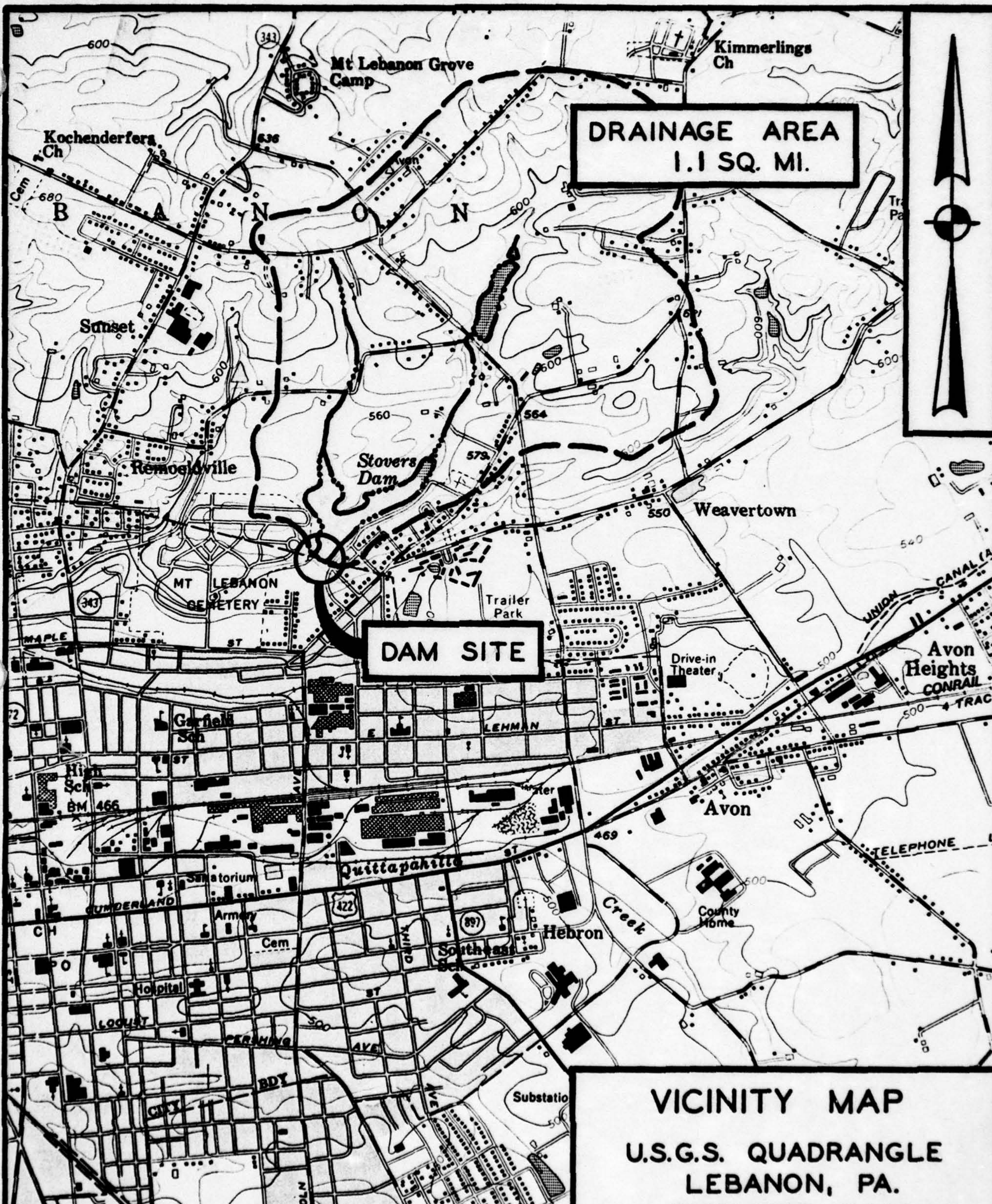
APPENDIX F

PLATES



LOCATION PLAN
STOVER'S DAM

PA. 600 PLATE I



VICINITY MAP
U.S.G.S. QUADRANGLE
LEBANON, PA.
STOVERS DAM

PA. 600 PLATE II